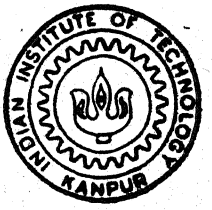
AN EXPERT SYSTEM FOR WELDING PROCESSES
—The WELDER

by

NEELESH KATIYAR



DEPARTMENT OF MECHANICAL ENGINEERING

INDIAN INSTITUTE OF TECHNOLOGY KANPUR

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AN EXPERT SYSTEM FOR WELDING PROCESSES
— *The WELDER*

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In Partial Fulfilment of the Requirements

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by

NEELESH KATIYAR

to the

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INDIAN INSTITUTE OF TECHNOLOGY, KANPUR

JUNE, 1994

DEDICATED
TO
MY PARENTS

CERTIFICATE

This is to certify that the present work on **AN EXPERT SYSTEM FOR WELDING PROCESSES,** *The WELDER* by Neelesh Katiyar (9210532) has been carried out under our supervision and has not been submitted elsewhere for the award of a degree .

(KRIPA SHANKER)
Professor
Industrial and Management Engg.
Indian Institute of Technology,
KANPUR-208016

(S. K. CHAUDHARY)
Asstt. Professor
Dept. of Mechanical Engineering
Indian Institute of Technology,
KANPUR-208016

June, 1994

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NEELESH KATIYAR

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ABSTRACT

In the present thesis, an attempt has been made to develop an expert system for the welding processes. This system has been developed for most of the weldable possible combination of similar or dissimilar materials. The system consists of five subsystems, namely Data input (INPUT), Selection of an optimal welding process (SELECT), Selection of joint design and preparations (PREPARE), Selection of consumables and non-consumables (RESOURCE) and Selection of welding parameters (PARAM).

Based on the inputs selected by the user in INPUT subsystem and considering various factors such as material properties, shapes and orientation of the jobs, welding thickness, welding position, welding environment and welded job application, the remaining subsystems (SELECT, PREPARE, RESOURCE and PARAM) suggest for an optimal process, joint design and preparations, consumables and non-consumables, and welding parameters. The functioning of all subsystems is dependent upon several knowledgebases which are structured in 47 database files. These knowledgebases have been framed as per the considered governing factors affecting process selection, working thickness calculation, joint preparations and their specifications, electrode specifications, parametric values etc..

The system has been implemented on an IBM PC-AT compatible with Dbase-4.2 as database management system.

Chapter 1

INTRODUCTION

Production of a part usually involves several manufacturing and related operations. For example, a typical part may require machining, inspection, joining, assembly, heat treatment etc. in a particular sequence. These operations, in general, exhibit, complex interdependencies in a sense that decisions about one affects the others. In order to effectively and efficiently utilize the modern day's capital intensive resources and to produce high quality products, an overall coordination of these complex interdependencies is needed. This coordination, to a great extent, is achieved by process planning which translates the part design data into the required manufacturing instructions, and this is an important link between design and manufacturing.

Process planning is defined as "the subsystem responsible for the conversion of design data to working instructions" (Groover and Zimmers [1]). Since the process planning involves great deal of decision making with ingenuity, a high skill is needed for this job. With tremendous developments both in design and manufacturing, interestingly it is quiet likely that there is a great deal of inconsistency among the process plans created manually by different planners for the same product. It is possible to create consistent and reliable plans using computers and computer based methodologies. This has lead to emergence of Computer Aided Process Planning (CAPP), regarded as a bridge between Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM).

1.1 Computer Aided Process Planning

The process planning technique can be categorized as :
(a) Variant(or Retrieval type) Process Planning , and
(b) Generative Process Planning.

The Variant Process Planning system uses part family and group technology concept as its foundation. There are already stored several process plans in the computer files. For a new part its family is identified, the corresponding process plan is retrieved, and then edited to the specifics of the part.

The Generative Process Planning system involves the use of computers to create an individual process plan from scratch using information available in a manufacturing database without human intervention. The computer makes use of a set of algorithms for the analysis of part geometry, material and other aspects to design an optimal process plan.

The real innovation in process planning has been provided by techniques which are related to Artificial Intelligence (AI) methodology, whereas the older programs had been built on conventional algorithmic procedures. For process planning, there must be a machine or a system that "thinks". Artificial Intelligence is a technique which makes computers to "think" like human beings. As a subfield of computer science, AI is a set of software techniques for representing data symbolically. The data is represented symbolically by showing relationships between data that imply meaning and concepts. AI processing of the data is also symbolic because it is performed on symbolic data, and also because it is performed in a way that implies reasoning, inferring and meaning.

1.2 Artificial Intelligence and Expert System

AI programs fall into three basic categories (Wendy and Rauch-Hindin [2]) : (a) Expert (or Knowledgebase) systems, (b) Natural Language systems, and (c) Perception systems

for vision, speech and touch.

When an organization has a complex decision or a problem, it often turns to experts for advice. The more complex and unstructured the situation, the more expensive is the advice, since the expert needs to be more familiar with the situation and the possible solutions. Expert Systems(ES), a branch of applied Artificial Intelligence, are an attempt to mimic such experts using the computers. Typically, an expert system is a decision making and/or problem solving integrated computerized package of hardware and software that can reach a level of performance comparable to - or even exceeding - that of a human expert, in some specialized and usually narrow problem area (Turban and Sepehri [3]).

Figure 1.1 shows the direction of flow of information in an Expert system.

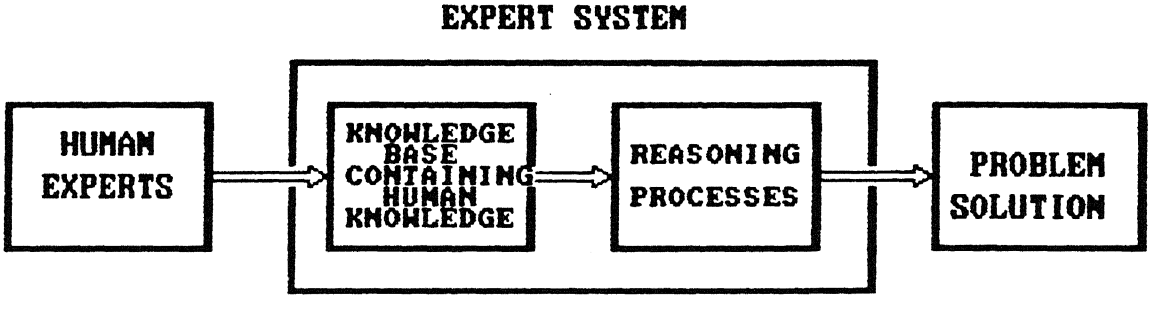


Fig. 1.1: Flow of information in expert system.

Expert systems are programs that use humanlike reasoning processes rather than computational techniques to solve problems in specific domains. These programmed, humanlike reasoning processes, in turn, rely on experienced human knowledge, or expertise which is encoded in the program in a structure called a "Knowledgebase". It is the one which is the most useful and interesting applications of AI. Knowledge based expert systems contain three main components as shown in Figure 1.2 :

1. A database of facts or assertions about some subject matter ; (knowledgebase).

2. A set of rules of the form 'IF' conditions and action (control mechanism), and

3. An inference engine (also called as monitor) that executes a set of rules, given a database. A monitor determines which rule can fire, resolves the conflict if more than one rule can fire, and then executes the chosen rule.

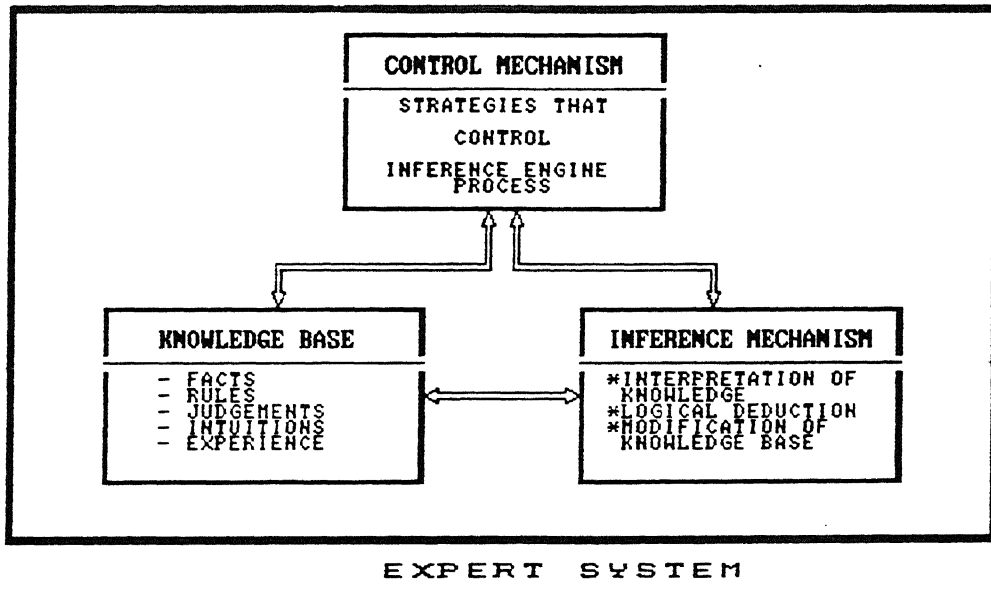


Fig.1.2: Three components of expert system.

Expert systems must have the capacity to update their knowledge easily to keep pace with real world. To be able to cope with real world problems, they must have flexible problem solving strategies, like human experts, which exhibits high performance. Like human experts, these systems also have capacity to explain what they have done and why. The expert systems have neither real intelligence nor can they completely replace human experts. It can be used as a supplement to the human expert by giving useful advice.

The database of facts and assertions about some subject matter, is a key to the success of an expert system. Database is defined as a collection of operational data with least repetition and stored on a centralized computing facility for the use of various users and retrievable at any time. Thus database can store, retrieve, edit, update and delete the data by means of a specialized software called "Database Management System (DBMS)".

It is quite important, in process planning function, to handle enormous well-structured data regarding operations, machine tools and other parameters. The database required for any CAD/CAM system is referred to as Engineering Database. In expert system, planners use knowledge bases rather using traditional database. Both are designed to store information. They differ significantly from each other in the type of the information they can store, the type of inter-relationship between data they can handle (that indicate either application of specific or common knowledge) and in what kind of training is needed for the person who updates the stored information.

Knowledge bases, like databases, also store straight-forward definite facts. But in addition knowledge bases store cause end effect knowledge, rules, and imprecise and probabilistic information as well (Date [4]).

1.3 Introduction to Welding Processes

Unlike the manufacturing processes employed to produce a single component, the joining processes are to assemble different members, either of the same material or of different materials, to yield the desired complex configuration. The joining processes are so intimately related to the overall production system that these are considered to form a class of manufacturing techniques. The joining of different elements can be either of temporary or permanent nature. Also, the mechanism of bonding may be either mechanical or atomic. All joining processes involving atomic bonding are of a permanent nature. A diagramatic representation is shown in Figure 1.3 (Smith [5]).

Modern methods of welding may be classified under two broad headings :
(1) Plastic welding or Pressure welding
(2) Fusion welding or Non-Pressure welding.

In the plastic welding, the pieces of metal to be joined are heated upto a plastic state and then forced together by external pressure. This procedure is used in forge welding,

resistance, thermit and gas welding in which pressure is required.

In the fusion welding, the material at the joint is heated to a molten state and allowed to solidify. This includes gas welding, arc welding, thermit welding etc.

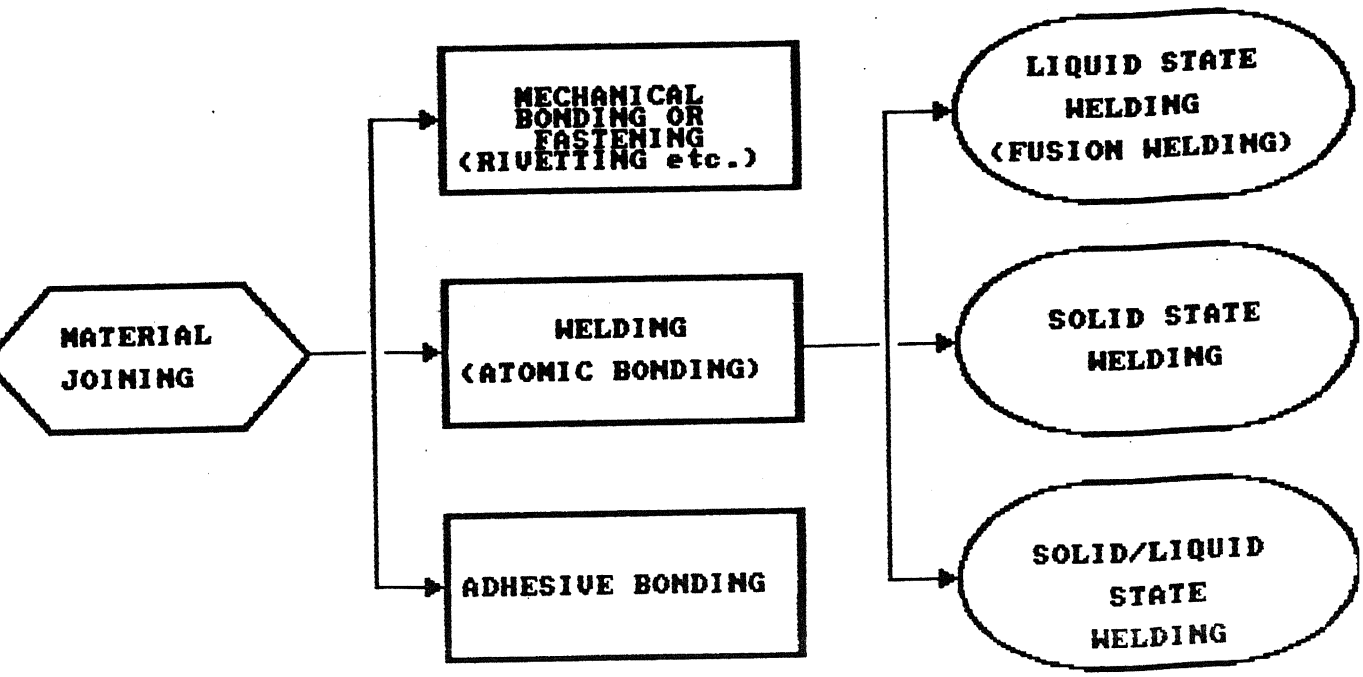


Fig. 1.3: Joining methods classification.

According to the categories of welding shown in the Figure 1.3, various welding processes can be grouped as shown in the Table 1.1.

Table 1.1 : Categories of Welding Process

S.No.	Welding Process	Code
I : LIQUID STATE WELDING (FUSION WELDING)		
1	Carbon Arc Welding	CAW
2	Electron Beam Welding	EBW
3	Electro-Gas Welding	EGW
4	Electro-Slag Welding	ESW
5	Flux-Cored Arc Welding	FCAW
6	Laser Beam Welding	LBW
7	Metal Inert Gas Welding-spray	MIG-spray
8	Metal Inert Gas Welding-pulsed	MIG-pulsed
9	Metal Inert Gas Welding-short-DIP	MIG-short-DIP
10	Plasma Arc Welding	PAW
11	Shielded Metal Arc Welding	SMAW
12	Submerged Arc Welding	SAW
13	Tungsten Inert Gas Welding-spray	TIG-spray
14	Tungsten Inert Gas Welding-pulsed	TIG-pulsed
15	Stud Arc Welding	
16	Thermit Welding	
17	Gas Welding	
II : SOLID STATE WELDING		
1	Diffusion Welding	DFW
2	Explosive Welding	EXW
3	Friction Welding	FRW
4	Ultrasonic Welding	USW
5	Cold Welding	
6	Forge Welding	
7	Roll Welding	
III : SOLID/LIQUID STATE WELDING		
1	Brazing	
2	Soldering	

Welding technology offers a fertile ground for the use of expert systems. Some areas where expert system can be used are :. welding procedure selection, robotic arc welding, maintenance and selection of consumables. One of the most useful applications of computer technology in the welding industry is database management system.

1.4 Overview of Literature Survey

The proliferation of the personal computer has caused wide acceptance of the technology in the welding industry. The variety of software developed over the years for technical disciplines has made the computer an integral tool of the engineer, but only recently has the discipline of welding been able to reap the harvest of this wide field of programs. This delayed gathering was the result of welding's late entrance into the arena of automation. At the present time, several expert systems have been successfully developed and implemented in the welding industry. Because of the recent advances in this technology, many more are under development. This section looks into some of the expert systems that are currently available to the welding industry and some that are under development.

1.4.1 Commercially available expert systems

Table 1.2 shows various commeercially available expert systems (Barborak, Dickinson and Modigan [6]).

Table 1.2 : Various Commercial Available Expert System

Name or Description of Expert system	Type	Source
Weldselector	Electrode Selector	CSM
Weldsymple	Symbol Generator	CSM
Weldcrack Expert	Diagnostic	Stone and Webster Engineering
Welding Procedure Selection Expert System	Procedure generator	Stone and Webster Engineering
Welding Qualification Test Selection Expert System	Test Selector	Stone and Webster Engineering
Weld Defect Diagnosis Expert System	Diagnostic	Stone and Webster Engineering
Weld Estimating Expert System	Cost analysis	Stone and Webster Engineering
Miller Expert Program	Diagnostic	Miller Electric

"Welding Procedure Selection Expert system" was developed by Stone and Webster engineering (Hathaway and Finn [7]) to identify appropriate welding procedures at field sites. Typical questions asked by the system might include which fabrication code is being used, the material to be welded, thickness of the material being welded and the process being used. After all relevant material specifications and related information have been entered, the program will flash the appropriate procedure on the screen and to the printer.

"Welder Qualification Test Selection Expert system" has also been developed by Stone and Webster engineering (Hathaway and Finn [7]) which chooses the correct test for welders taking all relevant factors into consideration. The qualification test is based on performance essential variables as well as materials. The user is prompted to enter data regarding job such as weld code, weld process, weld material, welding position and material thickness. The program then concludes with which test to administer.

"Weld Defect Diagnosis Expert system" has been developed by Stone and Webster engineering (Hathaway and Finn [7]), to identify the probable cause of weld defects on the basis of information regarding welding process variables and the welding techniques used, supplied by the user.

Stone and Webster has also developed "Weld Estimating Expert system" which estimates filler metal requirements for particular applications (Hathaway and Finn [7]). Typical data required to process this information include weld joint design, weld process, deposition efficiency of the weld metal etc. It can also calculate the required man hours to complete the job.

1.4.2 Expert system under development for welding

Table 1.3 shows some of expert systems under development (Barborak, Dickinson and Modigan [6]).

Table 1.3 : Various Expert Systems Under Development

Name or Description of Expert system	Type	Source
Weld-Assist	Procedure generator and diagnostic	Kuhne, Cary and Printz
Weld Costing System	Cost determination	James and Baker
Weld procedure Selection program	Procedure selection	Southampton University
Newcs	Real time monitoring diagnostics	General digital industry
Camtech 1000 and Adaptitech 1000	Real time monitoring diagnostics	Adaptive technologies
Weldex	Procedure generator	Technical University of Berlin
SAW Expert System	Procedure generator	Queen's University, Belfast
Weld Scheduler expert system	Procedure generator	Babcock and Wilcox
Expert Robot Welding System	Procedure generator	Sicard and Levine

"Weld Costing Expert system" for determining the cost of producing weld by a range of processes in materials of different types, dimensions and preparations was proposed by James and Baker (James and Baker [8]). This system was developed with KDS, an expert system development shell for IBM personal computers.

"Weld Procedure Selection Program" developed at Southampton University (Ribeirio [9]) with BASIC programming language on an APPLE II personal computer. This system selects the welding process best suited for welding aluminium alloy sheets upto 1.0 inch thick.

"Newcs", "Camtech 1000" and "Adaptitech 1000", are designed for application to particular field like naval shipyards, stationary cell application and mobile welding application (Reeves, Manley, Potter and Ford [10]) and (Kerth and Kerth [11]).

The "Weldex" expert system was designed using Turbo Prolog on an IBM-PC. The end result is a package advising a correct welding procedure, joint design, welding parameters and welding defects (Dorn and Majumdar [12]).

The work of Sicard and Levine (Sicard, Pierre, Levine and Martin [13]) proposes a combination of MIG and TIG welding robots and various sensors with an expert system and welding process controller.

S. Subramaniam (Subramaniam [14]) developed an expert system for a GMAW of aluminium and its alloys in Turbo-Pascal, which gives the complete welding procedure. The system gives the recommendation on the type of power source, type of welding current, electrode angle, joint design, specification of geometry, filler wire type and diameter, number of passes, welding current, arc voltage, contact tube to work distance, welding speed, shielding gas type and flow rate, and the preweld cleaning procedure.

Napelitano, Kulluck, Nagurka, Martukanitz and Dickerson [15] have worked on development of knowledge-based system for aluminium welding, named as "Filler Material Selector and Process Parameter Selector".

"Weldbest" can be used for any joint design to be welded by SMAW, SAW, TIG, MIG and FCAW to estimate the filler requirement per foot of weld and arc time. It is available from Edison Welding Institute (Cary [16]).

Table 1.4 shows the expert systems under development for EUROWELD under EUREKA Project EU 259 (Barborak, Dickinson and Modigan [6]).

Table 1.4 : Some Expert Systems Under Development for EUROWELD

Name or Description of Expert system	Type	Source
Weld gen	Procedure/Parameter generator	TWI
Weld sel	Consumable selection	TWI
Joint preparation	Procedure generator	Danish Welding Institute
High speed GMAW procedure	Procedure generator	TNO (Netherlands)
Welding of Aluminium alloys	Procedure/Process selector	TNO (Netherlands)
Resistance welding	Procedure selection	TNO (Netherlands)

The literature survey reveals that emphasis has not been given by the previous researchers on the selection of welding processes for joining various combination of base materials which may be similar or dissimilar. Most of the works on expert systems are related to limited processes and limited materials on the basis of particular criteria only.

1.5 Scope of Present Work

In this thesis an attempt has been made to develop an expert system for welding various types of similar materials and number of possible weldable dissimilar combination of materials using an optimal welding process selected on the basis of certain criteria. The system is designed to predict joint preparations, consumables and non-consumables, and parametric values for that optimal process. The system is interactive and user friendly. It is developed using Dbase-4.2 programming language on PC-AT.

1.6 Organization of the Thesis

The work carried out in this thesis is presented in five chapters.

Chapter 1 introduces the Computer Aided Process Planning, Expert system alongwith literature survey and scope of present work.

Chapter 2 presents the system analysis and design related with welding. In this chapter various decision making areas of welding alongwith the factors on which these areas depend, are also discussed.

Chapter 3 presents the implementation of expert system WELDER proposed in chapter 2 alongwith the structure of knowledge bases used in WELDER. This chapter also discusses the system flow chart and database flow chart showing interaction between various modules of WELDER and database files.

Chapter 4 discusses the results for few given set of inputs to the expert system WELDER.

Chapter 5 concludes the thesis with limitations of the present work and some suggestions for future work.

Chapter 2

SYSTEM ANALYSIS AND DESIGN

This chapter describes the various aspects of expert system analysis on the basis of which the system can be designed, and implemented.

2.1 Decision Making Areas of Welding

The primitive but still prevalent method of determining the working information in the welding industry is through the use of selection charts and tables. Although these have served their purpose well, there are advantages in the computer methods. For development of a software, the following aspects of decision making need to be considered.

1. Selection of preweld and postweld conditions.
2. Selection of welding process.
3. Selection of joint design and preparation.
4. Selection of appropriate consumables and non-consumables.
5. Selection of welding parameters.
6. Diagnosis of welding defects.
7. Estimation of welding cost.

9. Selection of skilled welder or welder qualification tests.

First five of the above-mentioned aspects are primary areas to work with in order to define the welding procedure. The remaining areas are important but secondary and follow the results of first five. A narrowed emphasis has been given to these primary aspects in the past. All these areas are interdependent, the variation in one accounting for the changes in the others.

2.1.1 Selection of preweld and postweld conditions

These are the preparations done to the working jobs to avoid unnecessary changes in the size, shape and properties of the jobs, as these changes do not contribute positively to the welding requirements. These preparations may be related to heating, cooling, coating, cleaning etc. . The selection of the type of preparation largely depends upon the material properties (discussed in section 2.1.2). The welded job application and the welding environment also affect the selection of these preparations.

2.1.2 Selection of welding process

Selection of a welding process requires a basic knowledge of the various processes and their relationship to variables such as base-material properties, geometrical specifications of the joint, equipment and working costs, orientation of the equipment, working environment, welded job application and welder's skill. The shape and orientation of a job and it's working thickness predict the geometric specifications of the joint. Discussions on these variables will help one to attain the level of understanding necessary to select adequately correct process for a specific application. Thus the selection of welding process depends upon the following important factors [17] :

(a) Base-material properties

(b) Geometrical specifications of jobs (e.g. shape and orientation)

(c) Working thickness

(d) Welding position

(e) Welding environment and welded job application

(f) Equipment and working costs

(g) Welder's skill

Base-material properties

The condition and form of the materials to be joined may affect the choice of welding process. Likewise, the welding process can have various effects on the base-materials ; e.g. high heat input may effect the mechanical properties of the base-material adversely. The following properties should be considered in the selection of a welding process.

(i) Physical properties

(ii) Mechanical properties

(iii) Chemical and Physio-chemical properties

(iv) Metallurgical properties

(i) Physical properties

The important physical properties, in context with weldability of the material, are as follows :

(a) Melting point

(b) Specific heat

(c) Latent heat

(d) Thermal and Electrical conductivity

(e) Boiling point

(f) Thermal expansion coefficient

(g) Change in volume on cooling

(h) Magnetic properties

Weldability generally is inversely proportional to both electrical and thermal conductivity,

latent heat, relative optimal melting temperature and specific heat. Boiling temperature of jobs must be high to avoid weld porosity. There must be an optimal melting point, as higher melting points needs high heat input given by a welding process and a low melting points may produce porosity in the weld joint (as in the case of Zinc). The coefficient of thermal expansion also has a significant effect on process selection as it imparts the distortion which produces residual stresses in the job. The change in volume on cooling produces the same effect as by the thermal expansion coefficient but less in order.

(ii) Mechanical properties

The mechanical properties of a material are the qualities that determine its behaviour when a load is applied. These properties determine whether a material is easy to bend, whether it is hard and brittle etc. This category of properties also affects the selection of welding process, considerably. The important mechanical properties, in context with weldability of material, are as follows :

(a) Condition of material (annealed,forged,chilled etc.)

(b) Yield point or 0.1 % proof stress

(c) Ultimate tensile strength

(d) Elongation

The condition of a material actually dictates the amount of internal stresses. Cracking occurs when a material is unable to resist the stresses that are applied to it because of lesser internal stresses. Cracking is also controlled by the elongation property of the welding job. Base-material that have higher hardness value or low yield strength are more difficult to join. These types of base-materials may require preheat treatment prior to welding.

(iii) Chemical and Physio-chemical properties

Chemical reactivity of a job also affect the weldability and can be categorized as:

(a) Oxidation

(b) Gas solubility

For joining to occur, the atoms on the surface of workpieces must be in intimate contact. Foreign matters, such as oxides and dirt, on the surface make fusion impossible or, at the best, difficult. Also, highly reactive metals such as titanium and zirconium are more difficult to join. Surface compounds, such as oxides must be removed prior to joining. Gas solubility changes the chemical composition of the base-material. Changes in the chemical composition of the base-material affect the process selection.

(iv) **Metallurgical properties**

These type of properties do not affect the selection of process considerably. The important properties, in context with weldability of the materials are as follows:

(a) Grain size

(b) Cooling rate

(c) Heat extraction

The materials having finer grains, have more ductility as compared to those having coarse grains.Thus the former type of materials are easier to weld. Higher cooling rate and heat extraction put the restriction on the selection of welding process in a way that it will opt for a process having higher heat input e.g. ESW, EGW etc. [17], (Leonard, August and Eugene [18]), and (West [19]).

Geometrical specifications of jobs

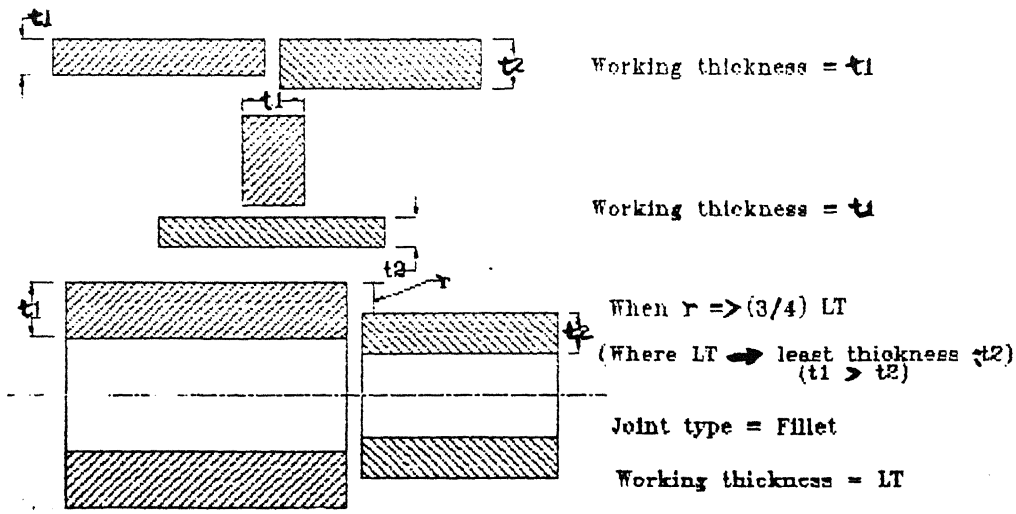
The possible shapes and orientations of jobs are as follows :

Shapes		Orientation	
1	Sheet and Plate	1	Longitudinal Butt
2	Large cylinder and Pipe	2	Longitudinal Lap
3	Tube	3	Tee
4	Bar	4	Angular
		5	Corner
		6	Various orientations as for attachment

The combination of shapes with a given orientation of the workpiece also affects the process selection because this decides the joint design and preparation (fillet/groove/etc.), and working thickness, which in turn affect the process selection. Joint design and preparation and selection of welding process are interdependent. Relatively, narrow openings and angles can be used in processes such as EBW and LBW. Submerged arc welding does not require as much of an angle as does SMAW or Oxyacetylene welding. With ESW, the opening is usually quite wide, and the bevelling is not required. In FRW applications, at least one of the parts to be joined must be rotatable [17], (Leonard, August and Eugene [18]), and (West [19]).

Working thickness of the jobs

The definition of working thickness depends upon the orientation. shapes and dimensions of the jobs. In most of the cases, it is referred to the least of the contact thickness. The working thickness defined for few combinations of jobs are shown below in Figure 2.1 :



There is a specific range of working thickness of jobs for each process. The process is selected, if the working thickness of the jobs lies inbetween the specified range, so that the imparted desired properties to the welded job is not less than that of either of the working jobs.

The welding of thin materials precludes the use of process with high heat input and deep penetration, such as SAW, ESW and Thermit welding. Conversely, the welding of thick materials precludes the use of processes with low heat input such as CAW, MIG etc.

Welding position

The welding position also restricts the processes to be used significantly as it defines the orientation of the welding apparatus being used for a particular process. The selection of welding position differs according to the welder's requirements. Following are the possible welding positions :

1. Flat
2. Horizontal
3. Vertical
4. Overhead

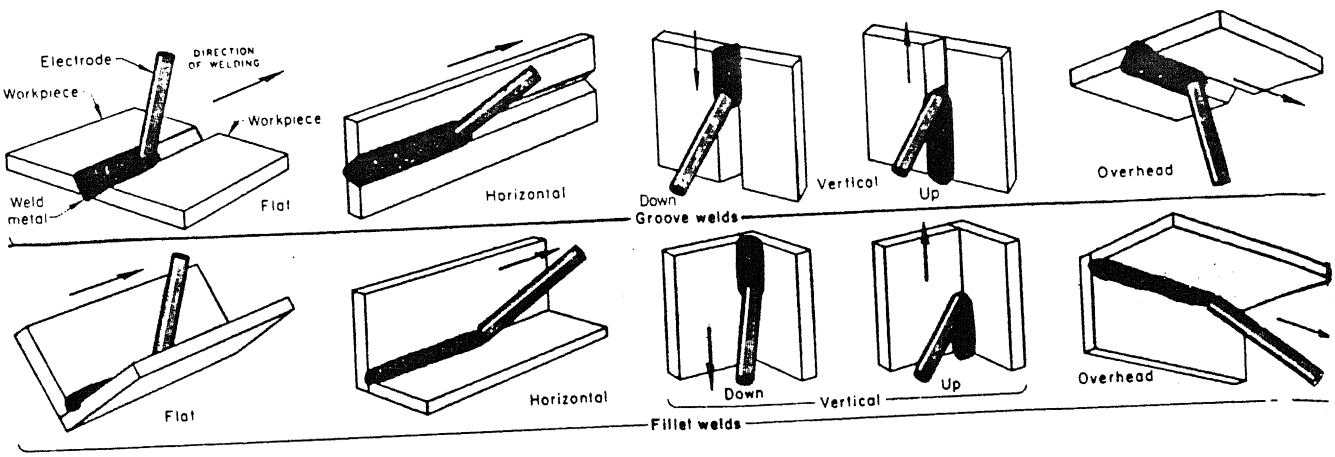


Fig. 2.2: Welding positions.

Certain welding processes are very versatile and adaptable and can be used in almost any location and position. There are some welding processes whose use is limited because of complicated installation requirements or equipment size. For these reasons, it is necessary to weigh the desire or need to use a specific welding process against an understanding of the limitations or impractical aspects of that process. For example, welding in the overhead position can not be accomplished with processes that produce large volume of molten metals e.g. SAW, ESW, EGW and Thermit welding [17] and (Houldcroft [20]).

Welding environment and welded job application

Welding is a versatile technology for industry use. For this reason, a great variety of product applications exist that use all available processes and in a wide variety of environments. However, every process can not be used for every welding application, as all have some limitations. Certain processes are very versatile and adaptable and can be used in almost any location and environment such as SMAW. Possible welding environment may be of following type :

1. Under water
2. Turbulent atmosphere
3. Normal atmosphere
4. Vacuum
5. Explosive atmosphere

These type of welding environment can be categorized as indoor or outdoor as well. For example, turbulent atmospheric condition may affect the functioning of shielding gas to be used in some processes. So MIG like processes are not advisable to use in this type of environment. Certain applications that encompass the major volume of welding in industry are :

1. Building and bridges
2. Storage tanks
3. Ship Building construction

4. Aerospace and aircrafts
5. Automotive and railroads

These application can be specified as the condition of loading that is to bear by welded job e.g. steady loading, fatigue loading, shock loading etc. . Under fatigue loading, brazing and soldering are not advisable.

For buildings and bridges, suggested processes are SMAW, SAW, MIG and FCAW. The other processes such as ESW, EGW and Stud welding are permitted but for specific applications. The most widely used processes in the erection/construction of storage tanks are SMAW and TIG with limited use of SAW, MIG and FCAW. The major welding process utilized in ship-building is SMAW, but there is a increased development in the use of SAW, MIG and FCAW. TIG continues to be dominant process in use, but SMAW, MIG, EBW, PAW and Brazing also are used for Aerospace construction. Resistance welding is the dominant process employed on automotive assembly lines. Other processes are FRW, GMAW, EBW, Brazing etc. in this type of industry [18].

Equipment and working costs

Welding equipments and system vary in cost from a few thousand rupees for a simple manual SMAW or Oxyfuel welding setup to well over a million rupees for a sophisticated fully automatic LBW installation. While selecting a process, all aspects of a job need to be analyzed, and equipment cost plays an important part in the evaluation. Working cost is also a important factor to be considered for process selection. This factor depends upon following variables [17] :

1. Preweld operation cost (e.g. heating, coating etc.)
2. Joint preparation cost
3. Consumables and Non-consumables costs
4. Cost involved in using welding apparatus
5. Labour cost

Welder's skill

A major factor to be considered in selecting a welding process is the level of welder's skill required to operate the equipment. Many welding applications are required to confirm to specific standards or codes. In this case, both the welder and the welding process must be qualified. The American Welding Society has numerous publications referencing welding processes and labour skill requirements [17].

2.1.3 Selection of joint design and preparation

The first consideration in the design of a weld joint is its ability to transfer load, the second being the cost. The ideal weld joint is one that can handle the loads imposed, usually with a substantial safety margin, and still be produced at minimum cost. Therefore, once the type of joint has been selected primarily on the basis of load requirement, the choice of weld to complete the joint should be determined by the effects of the structural design and layout on weld metals, accessibility and preparation requirements - variables that directly influence the cost of the weld joint. The size of the weld should always be designed with reference to the size of the thinner member to avoid unnecessary expenses.

Joint preparation can be broadly categorized as :
(1) Groove preparation weld
(2) Fillet preparation weld

The important design considerations for groove weld selection are the included angle, root opening, root face and radius at root. Following types of groove are used for groove preparation :

1. Square groove
2. Bevel groove

3. V - groove
4. J - groove
5. U - groove

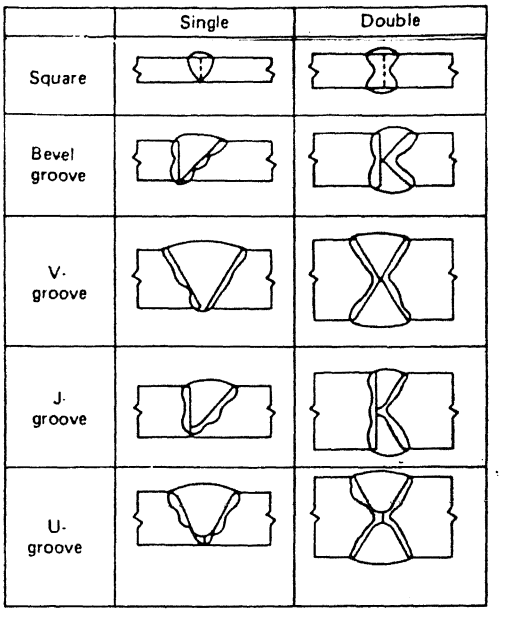


Fig. 2.3: Types of groove.

Fillet welds are welds approximately triangular in cross-section, joining two surfaces essentially at right angles to each other in a lap, tee, corner joints or angular joints. Basically they fill in a corner. Fillet weld require no preparation and are the most common type of weld used in structural works. Fillet weld is measured by the leg size of the largest right triangle that may be inscribed within the cross-sectional area of weld metal.

Joint design and preparation specifications are dependent on welding process, orientation of job, working thickness and type of materials. The characteristics of a welding process and orientation of jobs affect the selection of joint preparation. Working thickness greatly influences this selection as cost considerations become dominant here [17].

2.1.4 Selection of consumables and non-consumables

The selection of filler material for welding has paralleled the complexities of a growing industrial civilization. According to the American Welding Society's master chart of welding processes [21], "there are five processes using filler metals : Arc welding, brazing, flow welding, gas welding and thermit welding". Arc welding and brazing are widely employed for joining metals. Furthermore, the basic welding processes exclude soldering. Filler metals are classified differently for liquid and solid/liquid state welding. Under each grouping, the filler metals will be lined up by base-material group and by the process. An able welding engineer never relies on whims in choosing the classification and brand of electrode for a particular job. Actually, he considers atleast ten following factors before making his decision.

1. Desired welding standards to be met according to the application of welded job.
2. The type of material being joined.
3. The condition of the material to be welded (oily, rusty, oxidized, galvanized or scale -free).
4. The mechanical, physical and chemical properties needed for the service conditions to be encountered.
5. The joint test required (X-ray, betatron, magnaflux, ultrasonic, reflectoscope, mechanical test etc.).
6. The welding position encounter.
7. The type of joined preparation planned and quality of fit-up anticipated.
8. The kind of welding equipments used (a.c., d.c., manual or automatic).
9. Operating characteristics (good arc stability, easy slag removal, deep penetration, high welding speed, excellent deposit efficiency and many others).
10. Electrode cost per gram of deposited metal (burn-off rate and efficiency etc.).

The selection of appropriate filler metals essentially involves optimizing desired weld characteristics under metallurgical, chemical, mechanical and physical properties. In selecting the filler metal for welding a particular base-material, the welding engineer/expert system

considers the best possible combination of filler metal and base-material based on the following properties :

1. Compatibility in chemical composition with base material
2. Weld strength
3. Weld ductility
4. Resistance to weld cracking during solidification
5. Weld quality
6. Corrosion resistance
7. Finishing quality
8. Heat treatability of the complete weld

First five are the most essential properties while selecting the filler metals (Smith[5] and (Barnett[22]).

2.1.5 Selection of welding parameters

The parameters selection involves collecting information about a particular welding process, the basic form of the base-material (e.g. shape types), the joint design, the welding position, the base-material working thickness and, in certain cases. the type of filler material employed. The optimization of welding parameters for a particular process can be done on the basis of following factors :

1. Base-material type
2. Joint design and preparation
3. Geometrical form of base-material
4. Working thickness of base-material
5. Welding position
6. Filler metal to be used

The optimized combination of welding parameters can be taken from handbooks that are well maintained and represent the values considered optimal by welders with many

years of experience in welding. In this case, several conditions were tested at random by producing weldments using the welder/system 's recommendations for welding parameters. With minor modifications to the parameters, the welder/system functioned as expected and provided excellent starting conditions (Napolitano, Kulluck,Nagurka,Martukanitz and Dickerson [15]) and [17].

2.1.6 Diagnosis of welding defects

Welding process involves numerous variables which need control. The variation in any variable from optimal value means shifting the process from normal or ideal. This results into weld defect in working jobs. Welding defects are the reasons for not having the proper strength which was being expected from the welded jobs. This might even destroy the workpiece at welding place itself. The various important welding defects are as follows :

1. Improper joint design
2. Improper combination of welding parameters (e.g. current, voltage, travel speed of electrode, diameter of electrode etc.)
3. Improper weld operation
4. Unstable arc
5. Improper bead shape
6. Incomplete stag removal
7. Wrong welding technique

2.1.7 Estimation of welding cost

The welding cost includes various cost involved during process which are as follows :

1. Preweld operation cost
2. Joint preparation cost
3. Consumables and non-consumables costs
4. Cost involved in using particular process set-up

5. Labour cost

Estimation of welding cost is necessary for big job and mass production. So, many softwares have been developed to select the welding process on the basis of cost factor. The estimation of welding cost depends upon following welding factors :

1. Working thickness of jobs
2. Joint design and preparation
3. Welding process
4. Filler material size
5. Deposition efficiency
6. Other consumables and non-consumables used
7. Welder's skill

2.1.8 Estimation of welding time

The estimation of welding time is necessary prior to using the process in plant as it can help the planner to set subsequent processes in time and also to predict the duration in which the job can be completed. The calculation of welding time can be affected by the following factors :

1. Size of job
2. Filler diameter
3. Number of passes
4. Efficiency of welder
5. Nature of process
6. Working environment

2.1.9 Selection of skilled welder or welder qualification test

Selection of skilled welder is necessary to meet all requirements for a production weld. This selection is basically done on the basis of records of performance in the assigned jobs as many welders can have the same ability to perform a particular type of job. Thus, development of softwares in this decision making area of welding can extend a great deal of help to management in deciding which welder should be assigned to which job. In the developed software in this field (Barborak, Dickinson and Modigan [6]) and (Cary [16]), the decision is based on the following considered factors :

1. Weld material
2. Welding process
3. Welding position
4. Welding thickness
5. Welding consumables
6. Welding parameter

Chapter 3

IMPLEMENTATION

3.1 Introduction

In the present work, an effort has been made to implement some important decision making areas of welding (discussed in chapter 2). The areas included in the development of expert system are :

(1) Selection of welding process

(2) Selection of joint design and preparation

(3) Selection of consumables and non-consumables

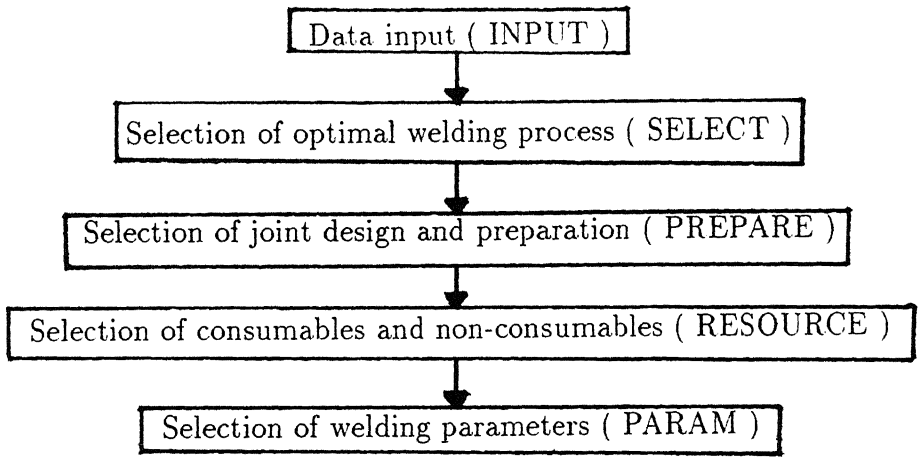
(4) Selection of welding parameters

The efficient integration of all abovementioned areas can give almost complete picture of welding procedure because these are the basic steps while welding the workpiece.

This chapter describes a proposed expert system named WELDER which is concerned with selection of joining process, joint preparations, consumables and non-consumables, and parametric values for joining process for a given combination of materials. It is implemented using dBase IV.2 on PC-AT.

3.2 Structure of the system

The system WELDER can be decomposed into five subsystems based on the functional aspects as given below. These subsystems are cascaded with serial order as shown.



3.3 Data input (INPUT)

The various inputs required are as follows :

1. Materials name
2. Jobs shape and dimensions
3. Jobs orientation
4. Welding position
5. Welding environment
6. Welded job application

This is the initial and independent subsystem with which the user interacts to give specific inputs necessary for the execution of WELDER. The remaining subsystems viz. SELECT, PREPARE, RESOURCE and PARAM are dependent upon the knowledge base and inputs acquired by the INPUT.

The WELDER provides various alternatives for each type of input from which the user is

expected to select one from each input category depending upon his requirements. Various alternatives under each category of input are as follows :

Table 3.1 : Various alternatives under each input category

Input Category	Alternatives	Figures
Material type	123 type of materials including metals, non-metals and alloys are incorporated in the list	3.2 to 3.3
Shape type	Sheet and plate Large cylinder and pipe Tube Bar	3.4 to 3.7
Orientation type	Longitudinal butt Longitudinal lap Tee Angular Corner Attachment	3.8
Welding position	Flat Horizontal Vertical Overhead Not specific	3.9
Welding environment	Indoor Outdoor	3.10
Welded job application	Fatigue loading Steady loading	3.10

Knowledgebase

This subsystem uses the various database files for specific purpose which are tabulated as follows :

Table 3.2 : Knowledgebase for INPUT module

Database file	Purpose
Material.dbf	123 types of weldable materials and their properties
Jobshape.dbf	Type of possible shapes and their codes
Joborient.dbf	Type of possible orientations and their codes
Weldpos.dbf	Type of welding position and their codes
Input1.dbf	To store inputs entered by user
Input2.dbf	To store particular inputs needed in the next module "SELECT"

The structure of these database files can be found in Appendix-B and detailed data in Appendix-C.

3.4 Selection of optimal welding process (SELECT)

It is a decision making subsystem of WELDER, and may be called as the "crux" of the system. Based on inputs selected by user in INPUT subsystem and considering various factors (discussed in section 2.1.2), this subsystem suggests either an optimal process or a list of alternatives for optimal process using knowledgebase. The user then has to enter one alternative out of the suggested process/processes. For the selection of optimal process, the WELDER has considered only five following important factors (out of the discussed seven factors in section 2.1.2).

1. Base-material properties
2. Geometrical specification of jobs (e.g. Shapes and orientation)
3. Working thickness of jobs
4. Welding position
5. Welding environment and welded job application

The WELDER has not considered equipment and working costs, and the welder's skill governing factors for this module. The WELDER has considered the following twenty types of processes in the atomic bonding welding category only (see Figure 1.3). In this category, three subcategories are considered.

(I) **Liquid state welding (Fusion welding)**

(1) Carbon Arc Welding (CAW)

(2) Electron Beam Welding (EBW)

(3) Electro-Gas Welding (EGW)

(4) Electro-Slag Welding (ESW)

(5) Flux-Cored Arc Welding (FCAW)

(6) Laser Beam Welding (LBW)

(7) Metal Inert Gas Welding-spray (MIG-spray)

(8) Metal Inert Gas Welding-pulsed (MIG-pulsed)

(9) Metal Inert Gas Welding-short-DIP (MIG-short-DIP)

(10) Plasma Arc Welding (PAW)

(11) Shielded Metal Arc Welding (SMAW)

(12) Submerged Arc Welding (SAW)

(13) Tungsten Inert Gas Welding-spray (TIG-spray)

(14) Tungsten Inert Gas Welding-pulsed (TIG-pulsed)

(II) **Solid state welding**

(1) Diffusion Welding (DFW)

(2) Explosive Welding (EXW)

(3) Friction Welding (FRW)

(4) Ultrasonic Welding (USW)

(III) **Solid/Liquid state welding**

(1) Brazing

(2) Soldering

This subsystem suggests the list of alternatives in two categories i.e. Recommended Process Group and Limited Use Group, after accounting for each of the governing considerations. The processes suggested in the first group are preferred over the second group.

Knowledgebase

This subsystem uses the various database files for specific purpose which are tabulated as follows :

Table 3.3 : Knowledgebase for SELECT module

Database file	Purpose
Input2.dbf	All inputs in this module
Smpromat.dbf	Processes for similar materials based on its properties
Dsmpromat.dbf	Processes for dissimilar materials based on its properties
Comshap.dbf	Type of recommended joint and working thickness data based on combination of shapes and orientation
Proshap.dbf	Recommended process based on combination of shapes and joint type
Prothick.dbf	Welding thickness range for each type of processes
Proposi.dbf	Recommended process based on welding position
Proapp.dbf	Recommended process based on welded job application
Criteria.dbf	Sequence/selection of processes according to the working criteria
Input3.dbf	All the necessary data needed in the next module "PREPARE"

The detailed structure of these files can be found in Appendix-B and illustrative data in Appendix-C.

The detailed discussions on the considered governing considerations are given in the following subsection while explaining the considered example which is gven below.

Example :

Ist material name = Low Carbon Steel (LCS)

IInd material name = LCS

Ist material shape = Sheet and Plate

IInd material shape = Tube

Orientation of jobs = Tee

Web of the Tee joint = Tube

Thickness of sheet(t1) = 0.5 inch

Diameter of Tube (d2) = 1.0 inch

Thickness of Tube (t2) = 0.25 inch

Welding position = Overhead

Joining environment = Outdoor

Application of welded job = Other than fatigue loading

3.4.1 Base-material properties

The choice of process depends upon certain properties of base-materials, discussed in section 2.1.2 .

This is the most important governing consideration, so the selection of optimal process always takes care of the material properties of the working jobs. In WELDER, there is a knowledge base containing recommended processes for joining the various combinations of materials, structured on the basis of material properties. So the WELDER has not used the material properties of both jobs, for suggesting the recommended process, directly. There are two database files (one for similar metals and another for dissimilar metals) named as "SMPROMAT.DBF" and "DSPROMAT.DBF". In former database file where, "R" denotes recommended process ; "L" denotes limited use process, and "N" denotes not recommended. For latter database file where, for process : "D" denotes diffusion welding ; "E" denotes electron beam welding ; "F" denotes friction welding ; "P" denotes explosive welding ; "B" denotes brazing, and "U" denotes ultrasonic welding ; "L" denotes laser beam welding ; "S" denotes soldering.

For the considered example, after accounting this factor, 18 out of 20 considered processes are recommended (in Recommended Process Group) e.g. CAW, EGW, ESW, EBW, FCAW, LBW, MIG, PAW, SMAW, SAW, DFW, EXW, FRW, USW, Brazing and Soldering (Here MIG includes MIG-spray, MIG-pulsed and MIG-short-DIP) (see Figure 3.11a).

3.4.2 Shapes and orientation of working jobs

As discussed in section 2.1.2, the combination of shapes with a given orientation of the working jobs also affects the process selection because this decides the type of joint (fillet, groove etc.) and working thickness, which in turn affect the process selection. The WELDER assumes following codes for considered type of shapes and orientations.

Shapes :

1 - Sheet and Plate

2 - Large cylinder and Pipe

3 - Tube

4 - Bar

Orientations :

1 - Longitudinal Butt type

2 - Longitudinal Lap type

3 - Tee type

4 - Angular type

5 - Corner type

6 - Attachments type

Now the system first retrieves procedure code from database file named as "COMSHAP.DBF", according to the indexed fields name e.g. "shap-code1", "shap-code2" and "orien-code".

For each value of field name "proc-code", system executes an unique processing and suggests joint type and working thickness (see Figure 3.11b). For the example considered the retrieved value of proc-code = 6 and for this value of proc-code

joint type = fillet (code = 2), and

working thickness = d2 = 1.0 inch

For welding of similar materials, a set of general criteria of working thickness based on process properties is used by WELDER for the shortlisting of welding processes. For

considered example, working thickness is greater than 0.5 inch, thus for calculated working thickness FCAW is usually preferred over SMAW because of higher speed, smaller fillet and deeper penetration. So considering this factor, 17 out of 18 processes (selected previously) are recommended e.g. CAW, EGW, ESW, EBW, FCAW, LBW, FRW, PAW, MIG, SAW, DFW, EXW, USW, Brazing and Soldering (see Figure 3.12a).

Then from database file "PROSHAP.DBF", system will select the possible processes based on indexed fields name e.g. "joint-code", "shapcode1" and "shapcode2", where, "Y" denotes Yes and "N" denotes No, for recommending the process for joining operation. Considering this factor, 15 out of 17 processes (selected in previous section) are recommended e.g. CAW, EGW, ESW, EBW, FCAW, LBW, MIG, SAW, DFW, EXW, USW, Brazing and Soldering (see Figure 3.12b).

3.4.3 Working thickness of the job

As discussed in section 2.1.2, the definition of working thickness depends upon the orientation, shapes and dimensions of the combination of the jobs. In most of the cases, it is referred to the least of the contact thickness. There is a specific range of working thicknesses of jobs for each process. The process is selected, if the working thickness of the entered combination of job lies inbetween the specified range, so that the imparted weld strength is not less than the strength of either of the working jobs. The effect of this factor can be shown by considering the same example. From calculation carried out by the system considering previous factor viz. shapes and orientation of jobs,

working thickness (WT) = 1.0 inch

The lower and upper limit of working thickness for each process is stored in database file "PROTHICK.DBF". Comparing WT of the considered combination of jobs with the specified range of each process, 9 shortlisted processes out of 15 (selected in previous section) are : EGW, ESW, EBW, FCAW, MIG-spray, MIG-pulsed, SAW, DFW and Brazing (see Figure 3.13a).

3.4.4 Welding position

As mentioned in section 2.1.2,the welding position also restricts the processes which can be used for joining operation, as it defines the orientation of the joining apparatus being used for a particular process. The selection of welding position differs according to the user's requirement. Following are the welding positions alongwith the codes considered by the WELDER :

Flat (1)
Horizontal (2)
Vertical (3)
Overhead (4)
Not specific (5)

For a given welding position, the WELDER selects processes on the basis of process characteristics. The effect of this factor can be demonstrated by considering the same example. For the considered example, welding position is Overhead, and for this position WELDER infers from the database file "PROPOSI.DBF" that the processes EGW, ESW and SAW can not be used.Thus, the 6 remaining recommended processes out of 9 (suggested in previous section) are : EBW, FCAW, MIG-spray, MIG-pulsed, DFW and Brazing (see Figure 3.13b).

The welding position not only affects the process selection but also the joint preparation, consumables and non-consumables selection, and parametric values immensely.

3.4.5 Other factors

Apart from above-mentioned factors, the WELDER includes a small questionnaire regarding joining environment of the process and application of the welded part as mentioned in section 2.1.2 , both of which also affect the process selection.

For the considered example,

Joining environment = Outdoor

Application of welded job = Other than fatigue loading

As jobs are being joined Outdoor, so as per the information stored in database file "PROENV.DBF" in the WELDER, the system omits the processes MIG-spray and MIG-pulsed from the list of processes suggested in the previous section. These processes have been omitted because turbulent outdoor environment conditions may affect the functioning of shielding gas to be used in these processes (see Figure 3.14a).

From database file "PROAPP.DBF", it is inferred that the second factor entered for the considered example will not affect the process selection. So, the recommended processes are reduced to 4 out of 6 (suggested in previous section) are : EBW, FCAW, DFW and Brazing (see Figure 3.14b).

3.4.6 Working criteria

For some combination of jobs to be joined, the WELDER suggests a list of alternatives for optimal process. To resolve this situation of multiple alternatives, there is a facility for arranging the processes in an order on the basis of desired working condition, from which user may select the optimal process. In the WELDER these working conditions are named as "Working Criteria". There are five working criteria contained in the WELDER, related to as-welded properties of the job and the process property. These criteria help the user to select the optimal process. All these criteria can be applied individually or in succession [21] and (Barnett [22]). The considered working criteria are as follows :

Process properties :

(1) Welding speed

(2) Set-up cost

As-welded properties :

(1) High quality weld

(2) Distortion

(3) Weld strength other than fatigue strength.

For the considered example, the WELDER suggests a list of alternatives for optimal process. To facilitate selection of optimal process, the working condition is entered as "Distortion". Using the database file "CRITERIA.DBF", the sequence of the processes in increasing level of distortion is as follows (see Figure 3.15a and 3.15b).

(1) Brazing

(2) DFW

(3) EBW

(4) FCAW

From this arranged list, the user is required to enter a desired optimal process. This selection of an optimal process marks the end of the module SELECT (see Figure 3.16a).

3.5 Selection of joint design and preparation (PREPARE

This subsystem suggests joint preparation specifications required prior to joining operation using knowledge base. In this subsystem there are two assumptions while advising for a joint preparations which are as follows :

(1) Joint preparation is assumed to depend on selected process, job orientation and working thickness. Although the material type affects the joint preparation, but not considerably. Thus the WELDER is assumed not to be dependent on the material type.

(2) It is assumed that prescribed joint preparation would give the 100 penetration (full strength weld) as the joining process is considered to be ideal.

The WELDER advises for groove and fillet type of joint preparations including design specifications. The knowledge-base contains the following type of groove preparations.

(a) Square groove

(b) Single Bevel groove

(c) Double Bevel groove

(d) Single V groove

(e) Double V groove

(f) Single U groove

(g) Double U groove

(h) Single J groove

(i) Double J groove

The WELDER suggests "No Preparation" for attachment type of orientation, as there is no consideration of joint strength. Attachment type of weld is used to support something, not to bear any short of load.

Knowledgebase

The PREPARE uses the various knowledgebases for two type of joint preparations (groove/fillet) while advising for joint design and preparation. The database files with a particular purpose are listed below :

Table 3.4 : Knowledgebase for PREPARE module

Database file	Purpose
Input3.dbf	To store all necessary inputs needed in this subsytem
Grjoipre.dbf	Groove joint design and preparation specifications
Vgrang.dbf	Included angle specifications for groove joint
Angrang.dbf	Included angle specifications for angular orientation of groove joint
Fjoipre.dbf	Fillet joint design and preparation specifications

The detailed structure and all data stored in above-mentioned files are given in Appendix-B and Appendix-C. For considered example in section 3.4, the output ot this module can be seen on screen as in Figure 3.16b.

3.6 Selection of consumables and non-consumables (RESOURCE)

The main function of this system is to select the specifications for the consumable and non-consumable materials, required for joining operation using optimal process using knowledgebase. These are based on the recommended specifications of American Welding Society.It selects on the basis of as-welded properties. In selecting the filler material for joining the particular base-material, the WELDER considers the best possible combination based on the following properties as discussed in section 2.1.4.

Knowledgebase

This subsystem uses only two knowledgebases for suggesting the consumables and non-consumables, the structure and data of which can be found in Appendix-B and Appendix-C.

Table 3.5 : Knowledgebase for RESOURCE module

Database file	Purpose
Input4.dbf	To store all necessary inputs needed in this subsytem
Electrod.dbf	Types of consumables and non-consumables for welding processes

The output of this subsystem, for the considered example is given in Figure 3.17a.

3.7 Selection of welding parameter (PARAM)

The main function of this subsystem is to advice the user regarding parametric values necessary for the optimal process selected for joining operation. The selection of optimized welding parameters for a optimal process has been done on the basis of considered following factors, out of the factors which has been discussed in section 2.1.5.

(1) Base-material type

(2) Working thickness of base-metal

(3) Welding position

For most of the processes, only one type of above-mentioned factors has been considered for selection of welding parameters.

Figure 3.17b shows the output of this module for considered example.

The subsystem SELECT selects a process based on subsystem INPUT and the functioning of rest of the three subsystems i.e. PREPARE, ASSIST and PARAM depends on output of SELECT and INPUT. The functioning of the subsystem SELECT is basically governed by various welding factors and considerations which have been discussed in the section 3.4.

Knowledgebase

This subsystem is highly interactive with database files. This module retrieves the welding parameters for the optimal process given by SELECT. For suggesting the welding parameters, the PARAM handles following twenty five database files including the input file for this module. The detailed structure and illustrative data can be found in Appendix-B and Appendix-C.

Table 3.6 : Knowledgebase for PARAM module

Database file	Purpose
Input5.dbf	To store all necessary inputs needed in this subsytem
Brazfill.dbf	Filler material for brazing
Brazpara.dbf	Welding parameters for brazing
Soldering.dbf	Welding parameters for soldering
Ebw.dbf	Welding parameters for EBW
Lbw.dbf	Welding parameters for LBW
Dfw.dbf	Welding parameters for DFW
Frw.dbf	Welding parameters for FRW
Usw.dbf	Welding parameters for USW
Esw.dbf	Welding parameters for ESW
Egw.dbf	Welding parameters for EGW
Caw.dbf	Welding parameters for CAW
Sawpara.dbf	Welding parameters for SAW
Smawpara.dbf	Welding parameters for SMAW
Smawweld.dbf	Welding parameters for SMAW
Pawpara.dbf	Welding parameters for PAW
Migpara.dbf	Welding parameters for MIG processes
Otmigpara.dbf	Welding parameters for MIG processes
Tigpara.dbf	Welding parameters for TIG processes
Ottigpara.dbf	Welding parameters for TIG processes
Migshgas.dbf	Shielding gas for MIG-SPRAY and MIG-PULSED
Dmigshgas.dbf	Shielding gas for MIG-SHORT-DIP
Pawshgas.dbf	Shielding gas for PAW
Fcawgrpa.dbf	Groove joint welding parameter for FCAW
Fcawftpa.dbf	Fillet joint welding parameter for FCAW

3.8 WELDER Procedure

The working of the WELDER is described as follows (see system flow chart in figure 3.18):

Step 1 : Enter the inputs required for execution of WELDER in a sequential manner.

The various inputs required are as follows :

(a) Name of materials

(b) Shape of jobs and dimensions

(c) Orientation of jobs

(d) Welding position

(e) Welding environment

(f) Application of welded job

Step 2 : Selection of processes on the basis of material properties for the entered combination of jobs.

Step 3 : Calculation of working thickness and possible joint type (fillet/groove/both/no preparation). Selection of processes for similar materials only, after applying general condition of working thickness.

Step 4 : Selection of processes, on the basis of type of shapes of job, out of the list of the processes selected in Step 2 (for dissimilar materials) or Step 3 (for similar materials).

Step 5 : Selection of processes, on the basis of working thickness of job, out of the list of the processes selected in Step 4.

Step 6 : Selection of processes, on the basis of welding position, out of the list of the processes selected in Step 5.

Step 7 : Selection of processes, based on other factors e.g. working environment of the jobs and welded job application, from the list of the processes selected in Step 6.

Step 8 : After Step 7, either an optimal process or a list of alternatives for optimal process is suggested. If latter is the case, then selection of optimal process is based on working criteria.

Step 9 : Selection of joint preparation specifications based on various factors are listed below :

(a) Possible joint type

(b) Optimal process

(c) Orientation

(d) Working thickness

Step 10 : Selection of consumables and non-consumables based on various factors are listed below :

(a) Optimal process

(b) Material type

(c) Welding position

(d) Other factors (e.g. impact resistance, penetration etc.)

Step 11 : Selection of parametric values for optimal process based on various factors are listed below :

(a) Optimal process

(b) Material type

(c) Working thickness

(d) Welding position

(e) Joint type

A user's manual has been provided in Appendix-A.

3.9 WELDER Knowledgebase

For selection at various steps, the WELDER uses several knowledgebases. These are structured in 47 database files consuming 372 Kbytes. These knowledgebases have been framed as per governing considerations affecting process selection, working thickness calculation, joint preparation specifications, consumables and non-consumables specifications, parametric values etc. The information of this knowledgebase has been gathered after extensive study of various books, journals and American Welding Society Handbook etc. (Smith [5]), (Leonard, August and Eugene [18]) , [23-33]. Appendix-B gives the detailed structure of each database file. Appendix-C contains the all structured data which are used by WELDER.

The interaction between the database files and WELDER functioning is shown in the system flow chart as discussed earlier in section 3.4 . In this section the detailed relationship between database files and modules/procedures of WELDER is shown in Figure 3.19 .

3.10 Result outputs

The outputs of WELDER are in convenient format on the screen. The results can also be taken on a printer.Sample screen outputs are shown in figure 3.16a,3.16b,3.17a,3.17b.These outputs are regarding with the following steps :

1. Selection of an optimal process
2. Selection of joint preparation for an optimal welding process
3. Selection of consumables and non-consumables for an optimal welding process
4. Selection of welding parameters for an optimal welding process

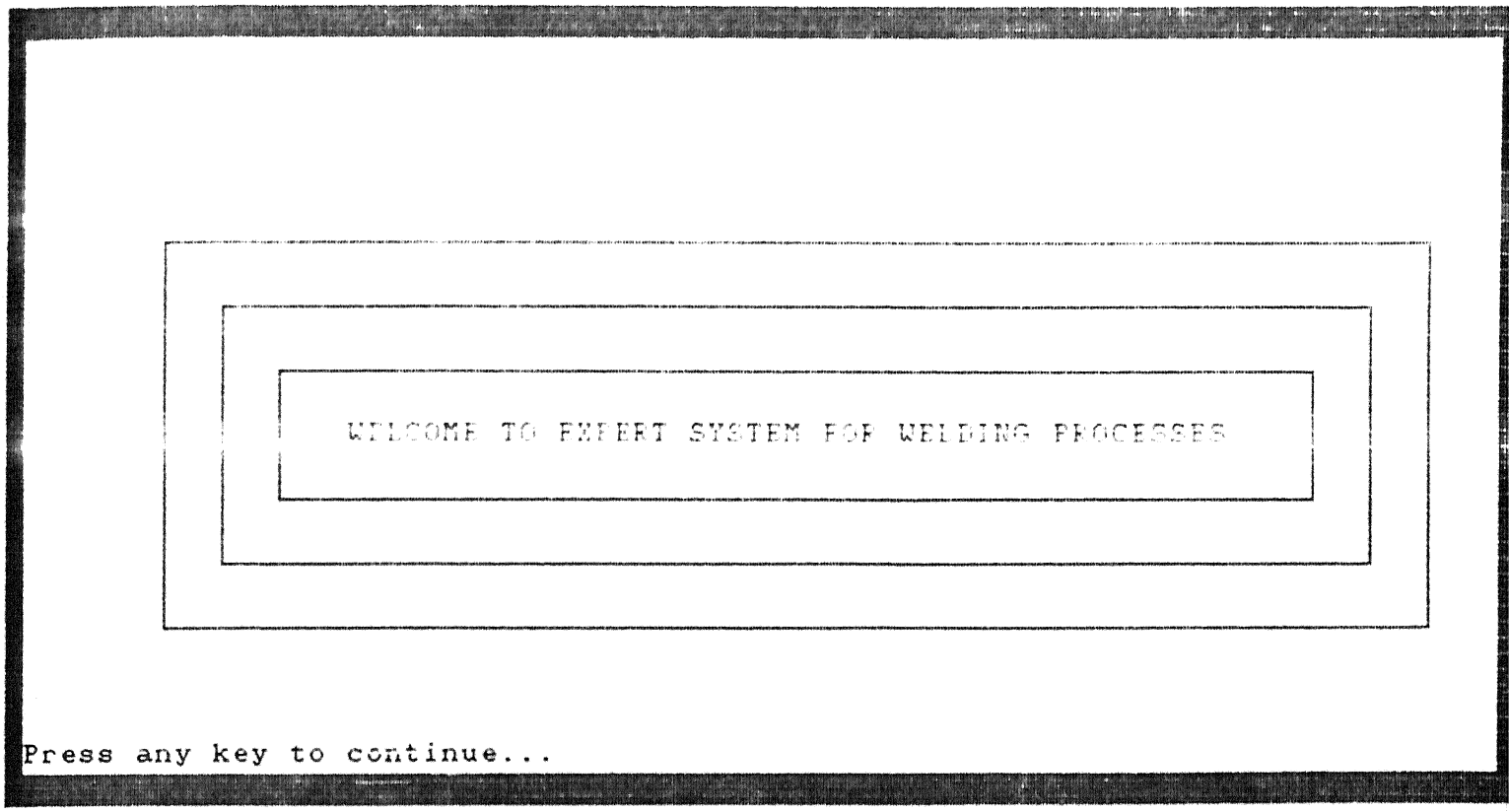


Fig. 3.1(a): An Expert System for welding process.

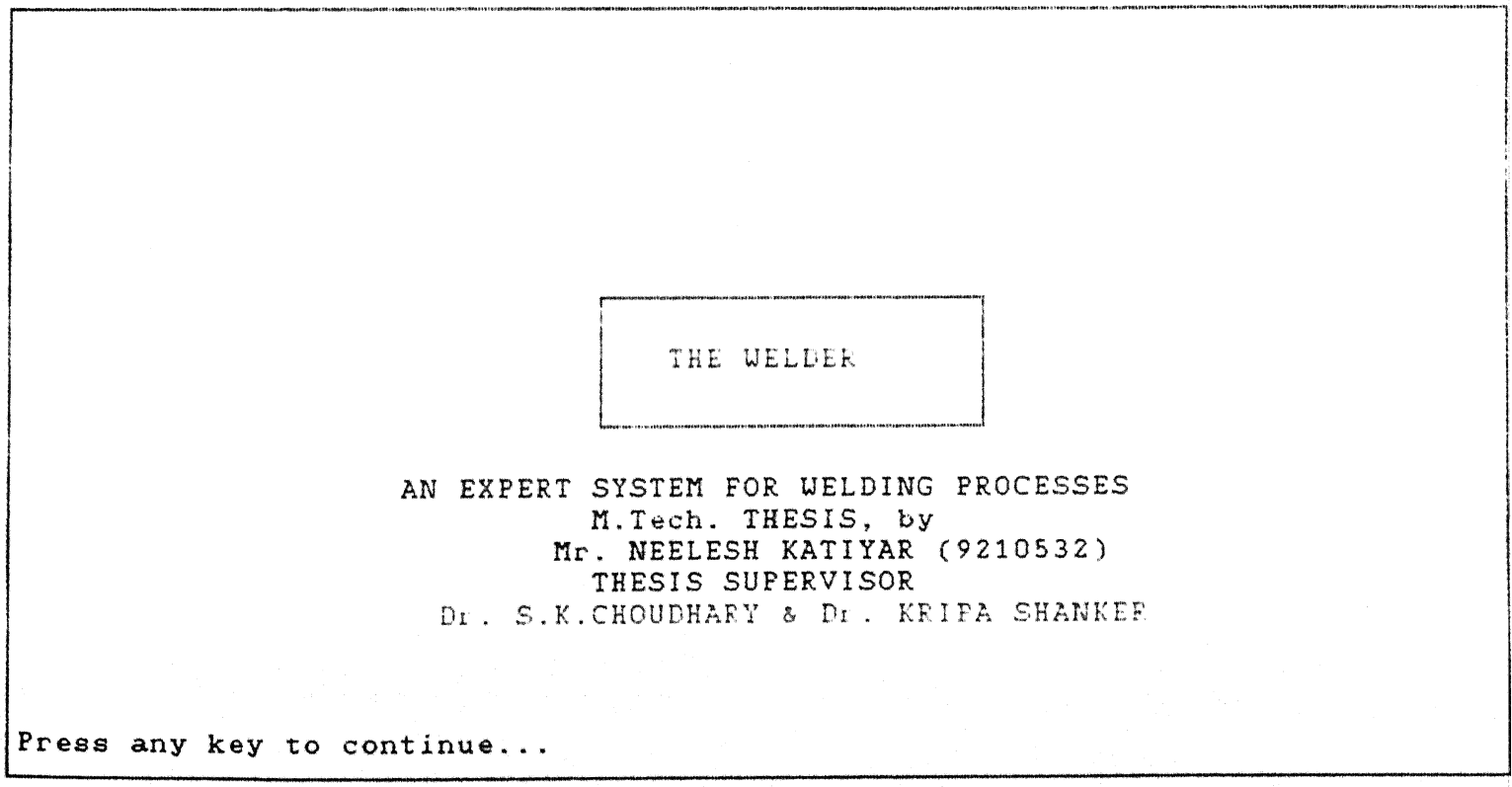


Fig. 3.1(b): An Expert System "WELDER".

ENTER THE FIRST MATERIAL CODE

GET THE CODE NUMBER OF MATERIAL FROM SHOWN TABLE

MATL_NAME	NUMBER
LOW_ALLOY STEEL (PLAIN Ni)	8
LOW_CARBON STEEL	1
MAGNESIUM & IT'S ALLOY	90
MALLEABLE_CAST IRON	7
MEDIUM_CARBON STEEL	2
MOLYBDENUM	91
MONEL	93
NICKEL	92
NICKEL SILVER	86

AFTER GETTING THE CODE FOR MATERIAL PRESS 'Esc' KEY

Fig. 3.2(a): Ist Menu of WELDER for the selection of First Material.

ENTER THE FIRST MATERIAL CODE

GET THE CODE NUMBER OF MATERIAL FROM SHOWN TABLE

ENTER THE CODE NUMBER OF 1st MATERIAL: 1

Press any key to continue...

Fig. 3.2(b): IInd Menu of WELDER for the selection of Ist Material.

ENTER THE SECOND MATERIAL CODE

GET THE CODE NUMBER OF MATERIAL FROM SHOWN TABLE

ENTER THE CODE NUMBER OF 1st MATERIAL: 1

MATL_NAME	NUMBER
LOW_ALLOY STEEL (Mn+Mo)	10
LOW_ALLOY STEEL (Ni+Cr)	13
LOW_ALLOY STEEL (Ni+Cu)	9
LOW_ALLOY STEEL (PLAIN Cr)	14
LOW_ALLOY STEEL (PLAIN Ni)	8
LOW_CARBON STEEL	1
MAGNESIUM & IT'S ALLOY	90
MALLEABLE_CAST IRON	7
MEDIUM_CARBON STEEL	2

AFTER GETTING THE CODE FOR MATERIAL PRESS 'Esc' KEY

Press any key to continue...

Fig. 3.3(a): IIIrd Menu of WELDER for the selection of second material.

ENTER THE SECOND MATERIAL CODE

GET THE CODE NUMBER OF MATERIAL FROM SHOWN TABLE

ENTER THE CODE NUMBER OF 1st MATERIAL: 1
ENTER THE CODE NUMBER OF 2nd MATERIAL: 1

Press any key to continue...

Fig. 3.3(b): IVth Menu of WELDER for the selection of second material.

ENTER THE SHAPE CODE OF FIRST MATERIAL

GET THE CODE OF 1st MATERIAL SHAPE FROM SHOWN TABLE

SHAP_TYPE	SHAP_CODE
SHEET OR PLATE	1
LARGE PIPE OR CYLINDER	2
TUBE	3
BAR	4

AFTER GETTING THE SHAPE CODE FOR 1st MATERIAL PRESS 'Esc' KEY

Fig. 3.4(a): Vth Menu of WELDER for the selection of first job shape.

ENTER THE SHAPE CODE OF FIRST MATERIAL

GET THE CODE OF 1st MATERIAL SHAPE FROM SHOWN TABLE

ENTER THE SHAPE CODE OF 1st MATERIAL: 1

Press any key to continue...

Fig. 3.4(b): VIth Menu of WELDER for the selection of first job shape.

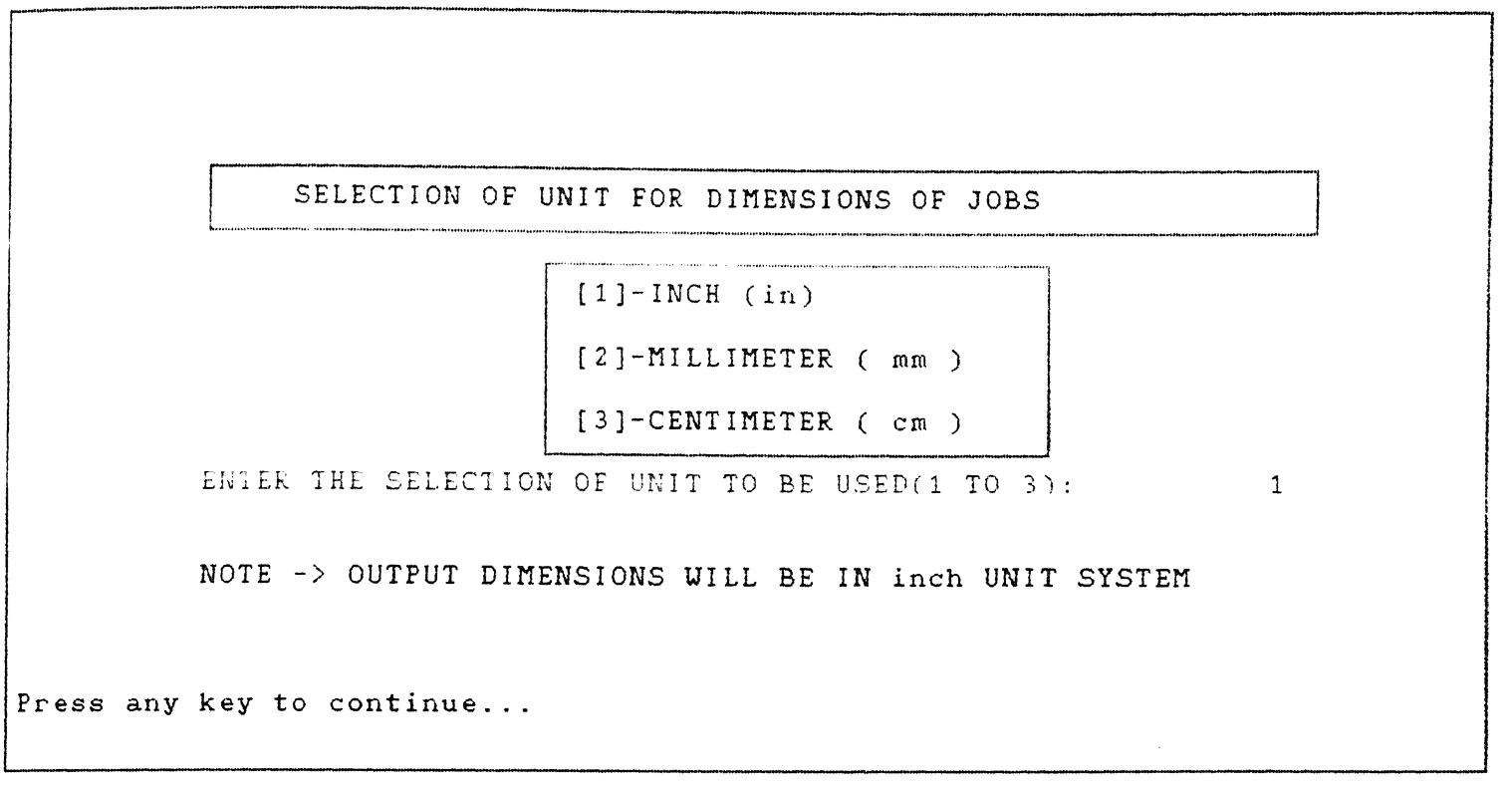


Fig. 3.5(a): VIIth Menu of WELDER for the selection of unit for dimensions of shapes.

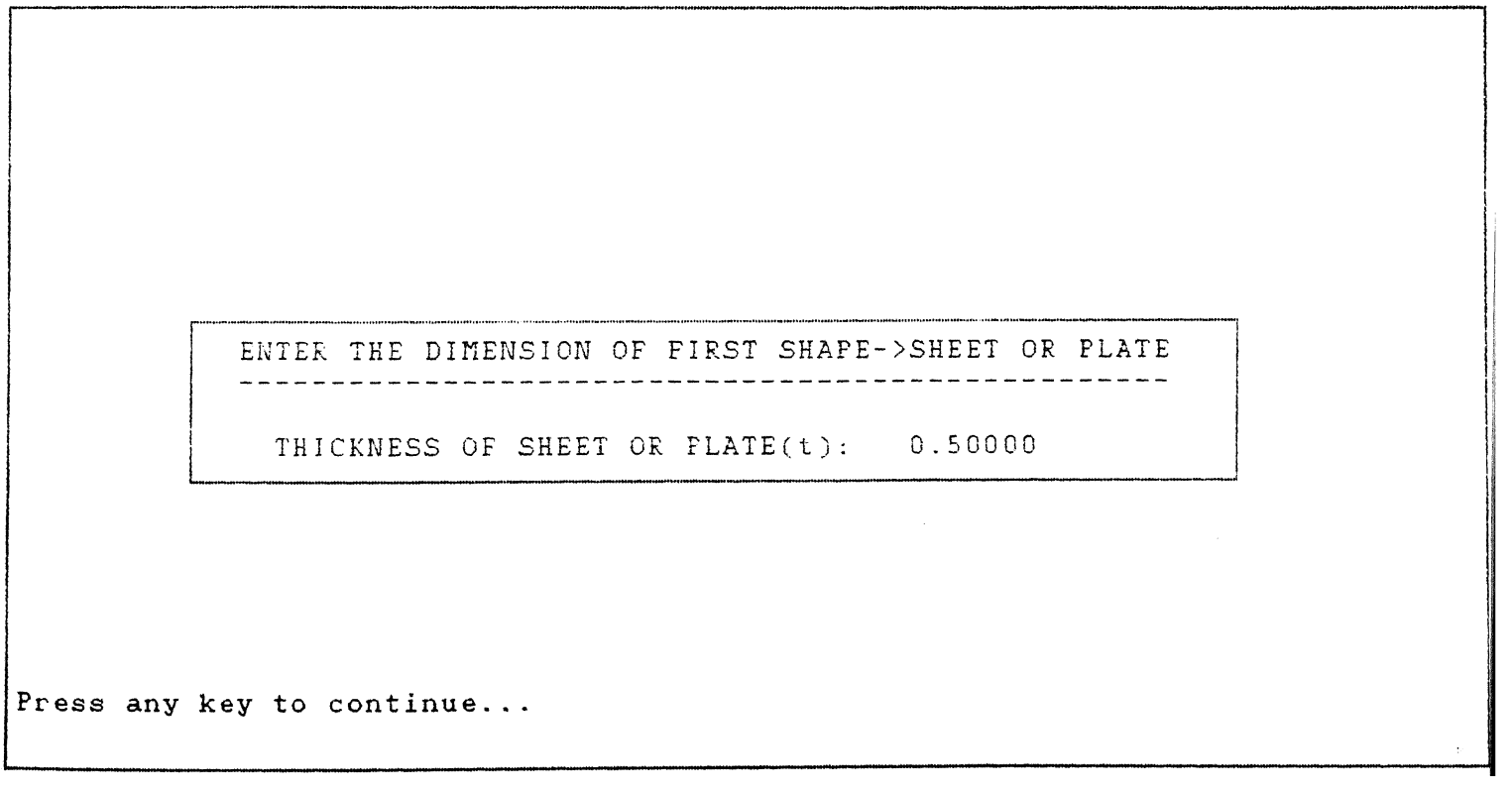


Fig. 3.5(b): VIIIth Menu of WELDER for dimensions of first shape.

ENTER THE SHAPE CODE OF SECOND MATERIAL

GET THE CODE OF 2nd MATERIAL SHAPE FROM SHOWN TABLE

SHAP_TYPE	SHAP_CODE
SHEET OR PLATE	1
LARGE PIPE OR CYLINDER	2
TUBE	3
BAR	4

AFTER GETTING THE SHAPE CODE FOR 2nd MATERIAL PRESS 'Esc' KEY

Fig. 3.6(a): IXth Menu of WELDER for the selection of second job shape.

ENTER THE SHAPE CODE OF SECOND MATERIAL

GET THE CODE OF 2nd MATERIAL SHAPE FROM SHOWN TABLE

THE ENTERED CODE NUMBER OF 1st MATERIAL: 1

ENTER THE CODE NUMBER OF 2nd MATERIAL: 3

Press any key to continue...

Fig. 3.6(b): Xth Menu of WELDER for the selection of second job shape.

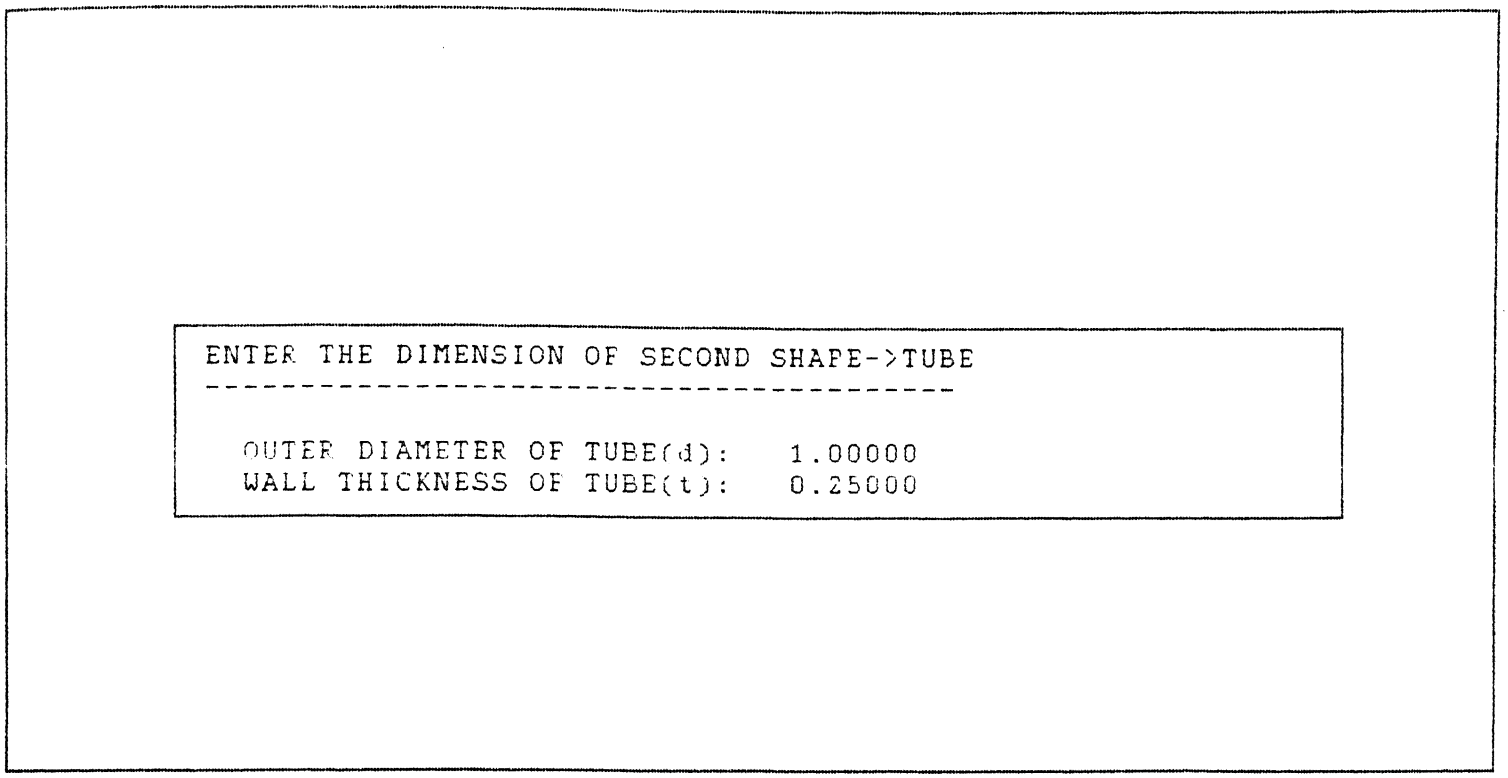


Fig. 3.7: XIth Menu of WELDER for dimensions of second job shape.

ENTER THE ORIENTATION CODE OF THE JOBS

GET THE CODE FOR THE ORIENTATION OF JOBS FROM SHOWN TABLE

ORIEN	ORIEN_CODE
LONGITUDINAL BUTT JOINT	1
LONGITUDINAL LAP JOINT	2
TEE JOINT	3
CORNER JOINT	4
ANGULAR JOINT	5
ATTACHMENT	6

AFTER GETTING THE ORIENTATION CODE FOR JOBS PRESS 'Esc' KEY

Fig. 3.8(a): XIIth Menu of WELDER for the selection of orientation of jobs.

```
                ENTER THE ORIENTATION CODE OF THE JOBS
                *-------------------------------------*
GET THE CODE FOR THE ORIENTATION OF JOBS FROM SHOWN TABLE


      ENTER THE CODE NUMBER OF ORIENTATION:  3




Press any key to continue...
```

Fig. 3.8(b): XIIIth Menu of WELDER for the selection of orientation of jobs.

```
                ENTER THE CODE OF WELDING POSITION
                *---------------------------------*
GET THE CODE FOR THE WELDING POSITION FROM SHOWN TABLE
```

WELD_POSI	POSI_CODE
FLAT	1
HORIZONTAL	2
VERTICAL	3
OVERHEAD	4
NOT SPECIFIC	5

```
AFTER GETTING THE POSITION CODE, PRESS 'Esc' KEY
```

Fig. 3.9(a): XIVth Menu of WELDER for the selection of welding position.

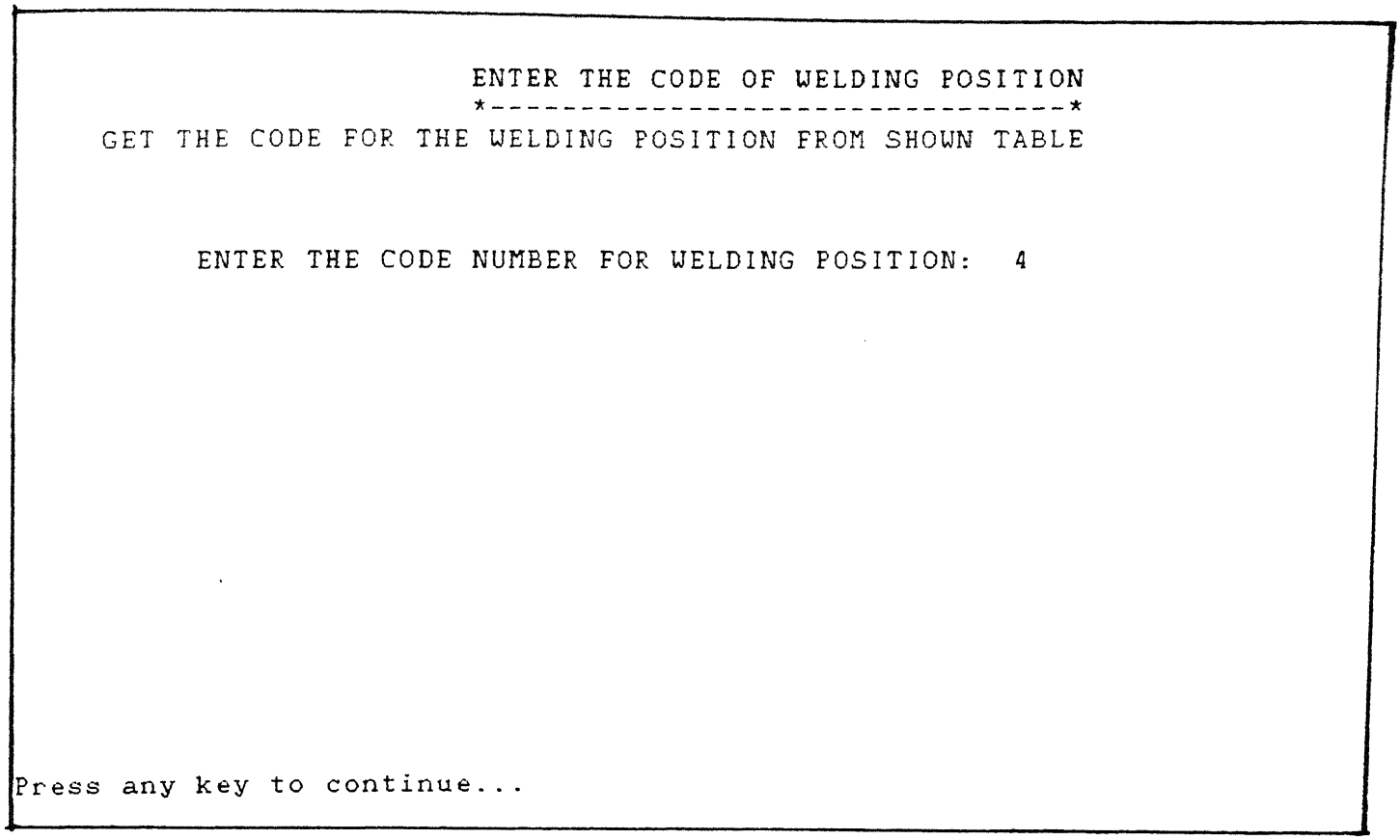


Fig. 3.9(b): XVth Menu of WELDER for the selection of welding position.

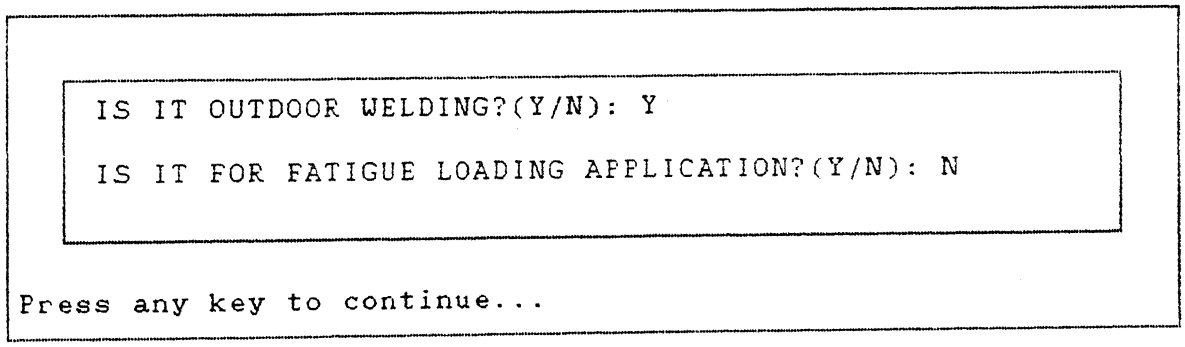


Fig. 3.10: XVIth Menu of WELDER for the selection of welding environment & welded job application

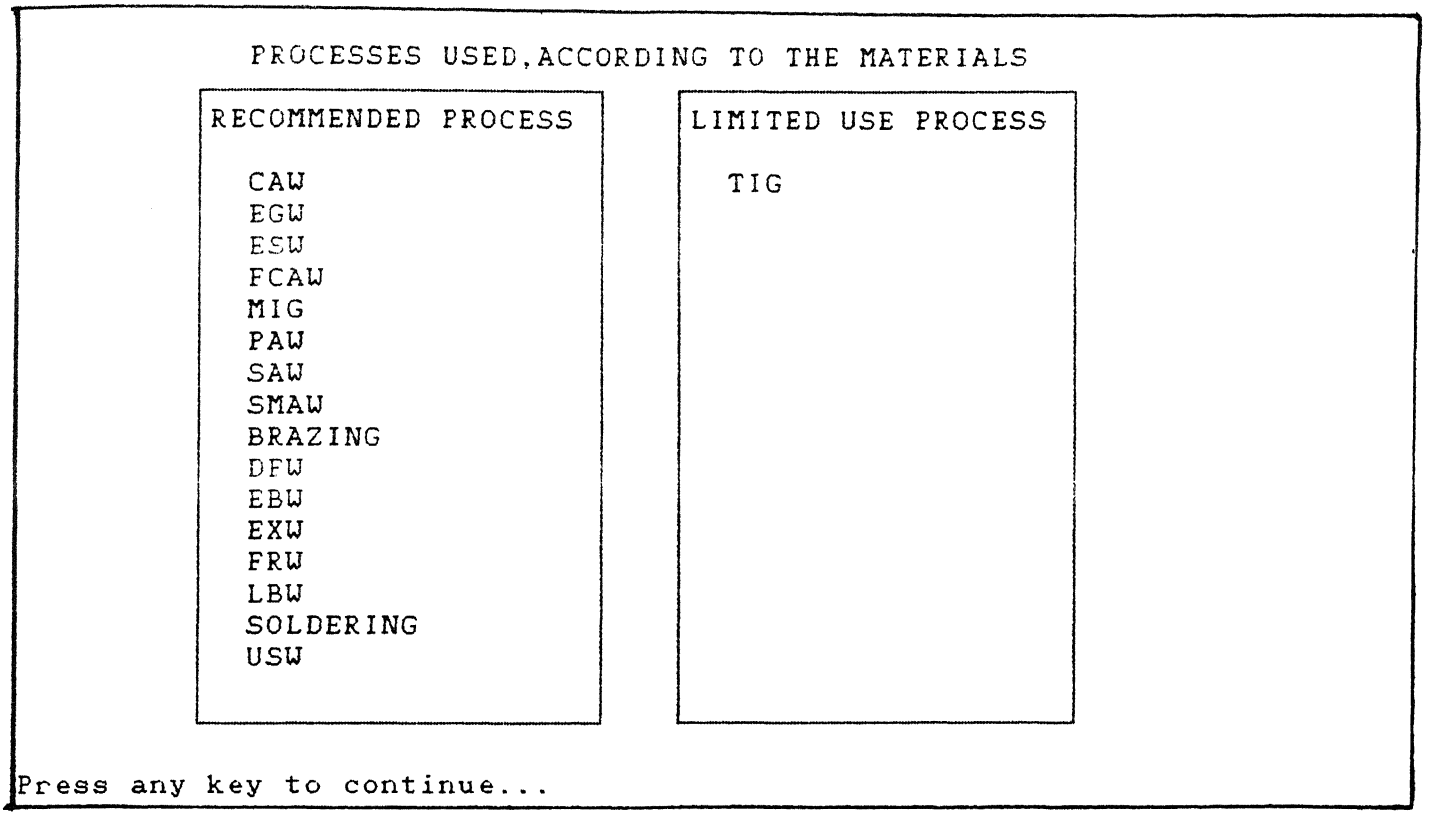


Fig. 3.11(a): XVIIth Menu of WELDER for showing the process based on type of materials.

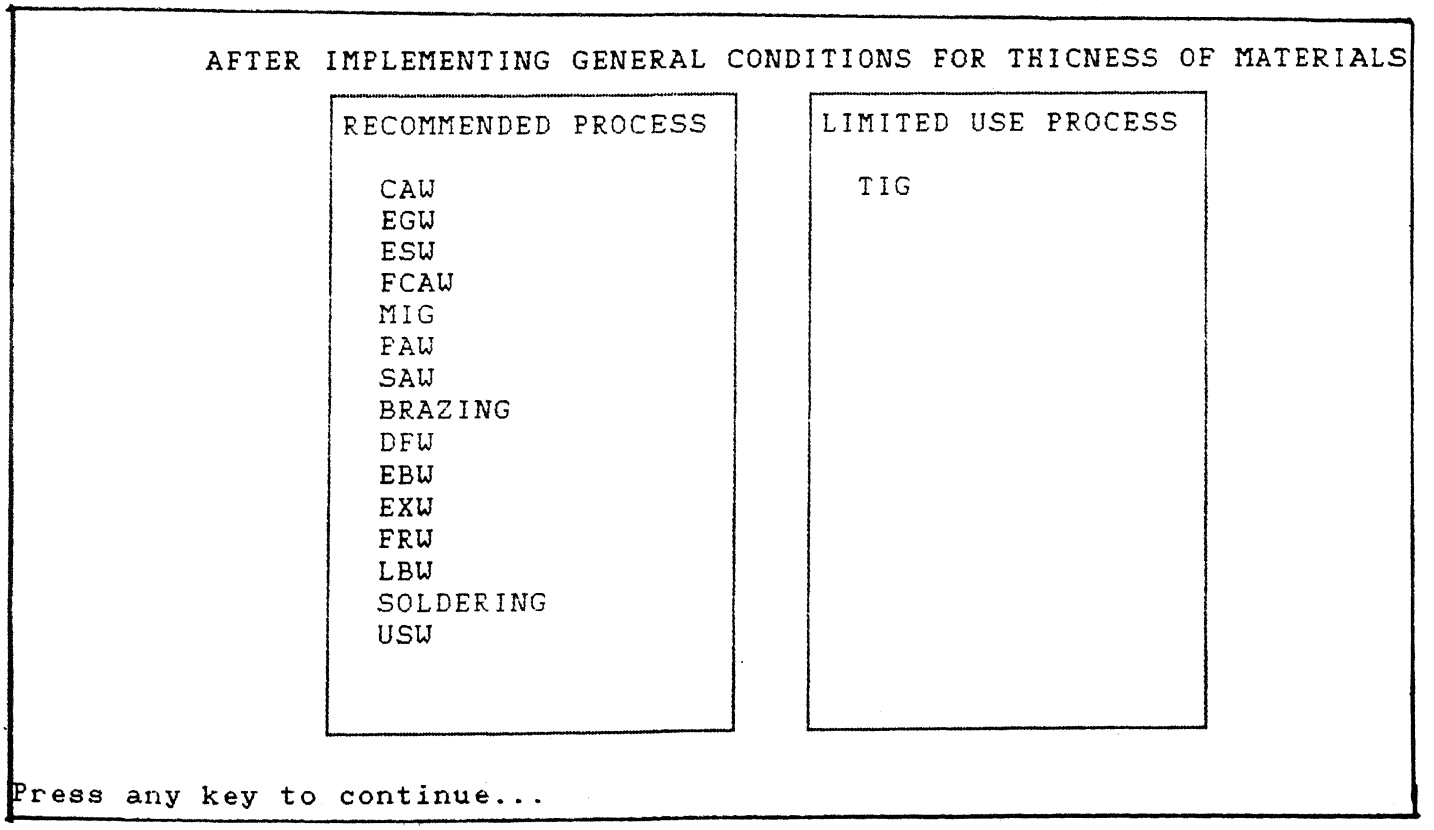


Fig. 3.11(b): XVIIIth Menu of WELDER for showing the processes including general conditions of working thickness of jobs.

TYPE OF POSSIBLE JOINT FOR THE WELDING

FILLET TYPE

Press any key to continue...

Fig. 3.12(a): XIXth Menu of WELDER for showing the recommended type of joints.

PROCESSES FOR FILLET WELD, INCLUDING SHAPE FACTOR ALSO

RECOMMENDED PROCESSES	LIMITED USE PROCESSES
CAW	TIG
EGW	
ESW	
FCAW	
MIG	
SAW	
BRAZING	
DFW	
EBW	
EXW	
LBW	
SOLDERING	
USW	

Press any key to continue...

Fig. 3.12(b): XXth Menu of WELDER for showing the processes including shapes combination of jobs.

PROCESSES FOR FILLET WELD,INCLUDING THICKNESS FACTOR ALSO

RECOMMENDED PROCESSES	LIMITED USE PROCESSES
EGW	
ESW	
FCAW	
MIG_SPRAY	
SAW	
BRAZING	
DFW	
EBW	
MIG_PULSED	

Press any key to continue...

Fig. 3.13(a): XXIth Menu of WELDER for showing the processes including working thickness of jobs.

PROCESSES FOR FILLET WELD,INCLUDING WELDING POSITION FACTOR ALSO

RECOMMENDED PROCESSES	LIMITED USE PROCESSES
FCAW	
MIG_SPRAY	
BRAZING	
DFW	
EBW	
MIG_PULSED	
	NO PROCESS
	-AVAILABLE
	-AMONG
	-CONSIDERED
	-PROCESSES.

Press any key to continue...

Fig. 3.13(b): XXIIth Menu of WELDER for showing the processes including welding position factor.

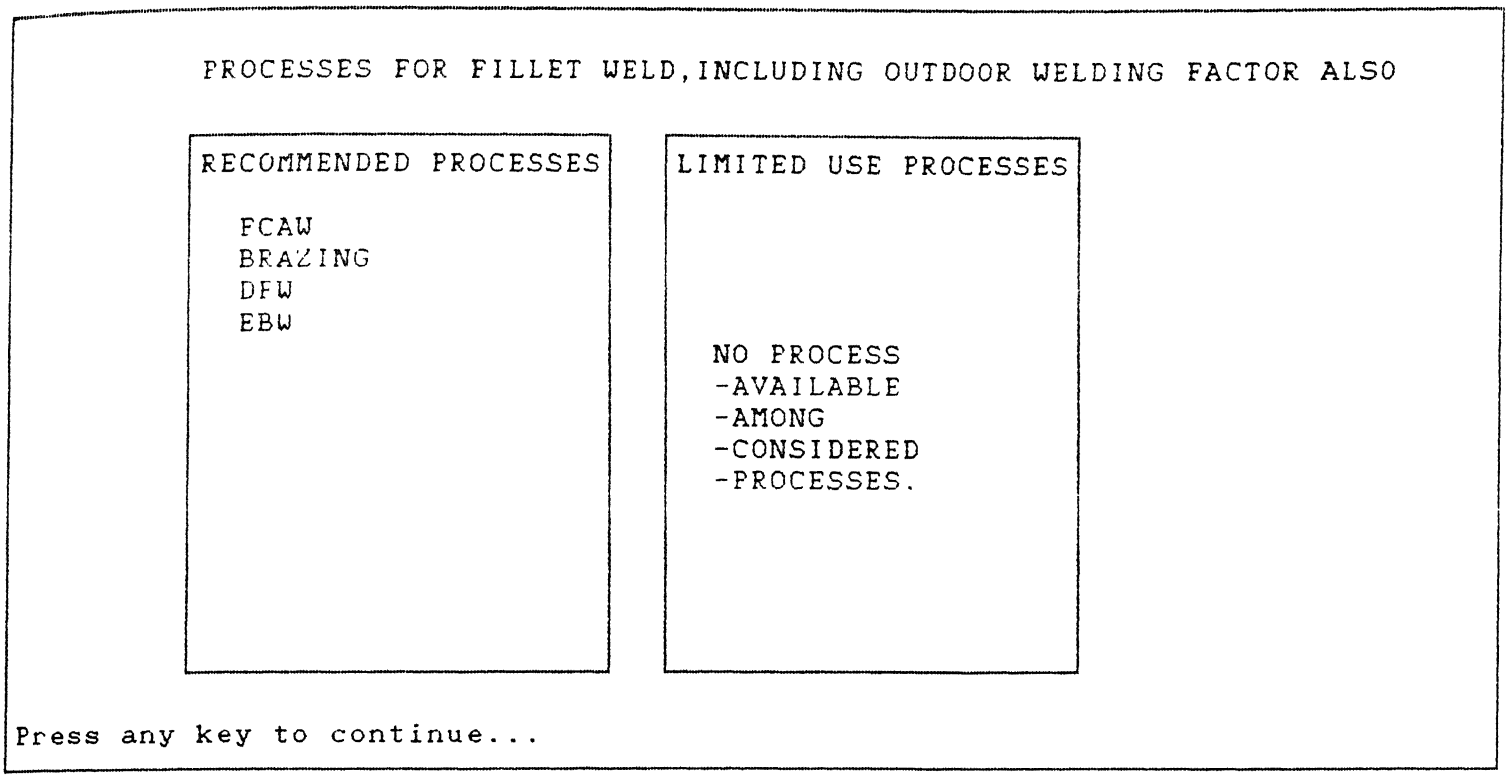


Fig. 3.14(a): XXIIIrd Menu of WELDER for showing the processes including welding environment factor.

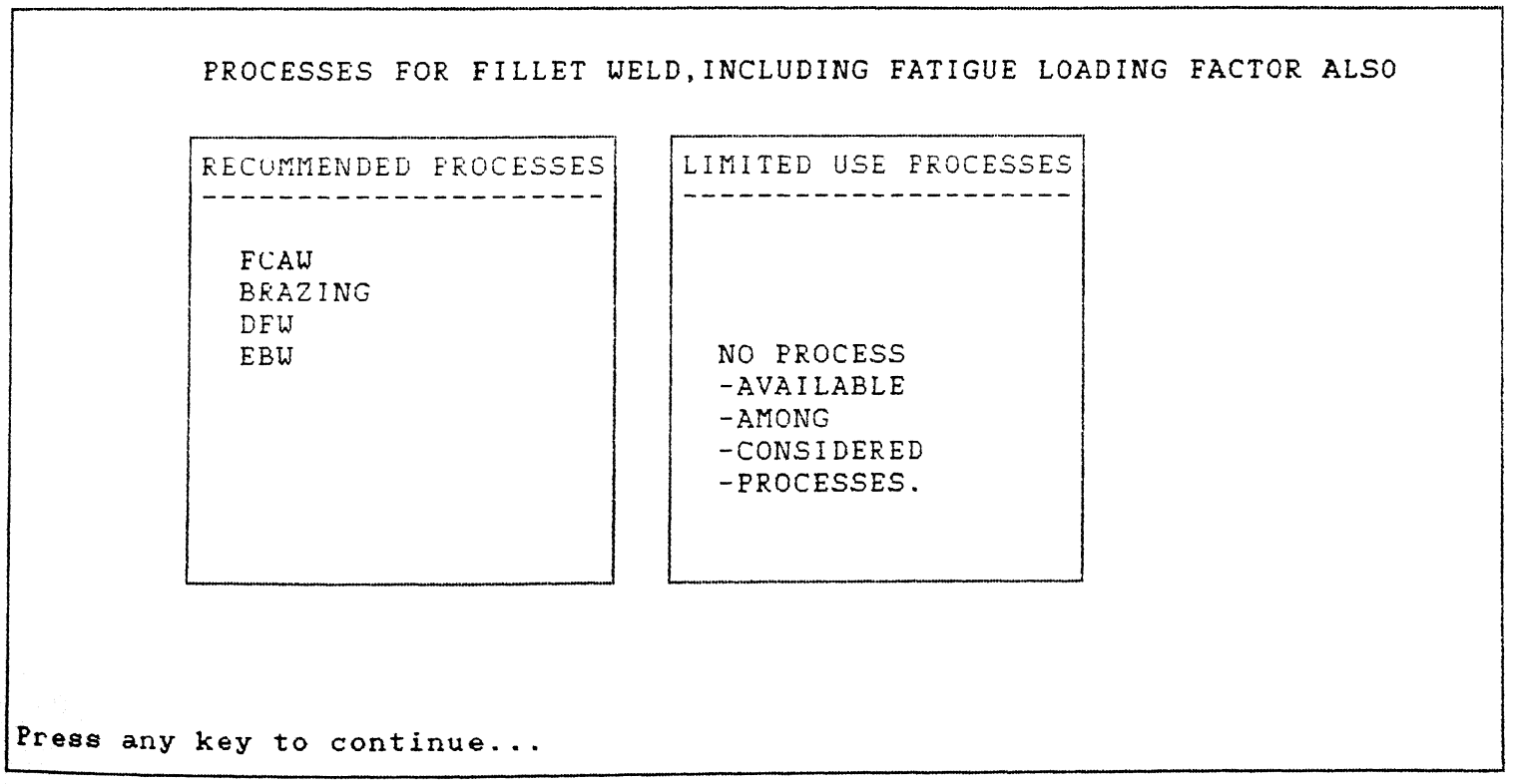


Fig. 3.14(b): XXIVth Menu of WELDER for showing the processes including welded job application factor.

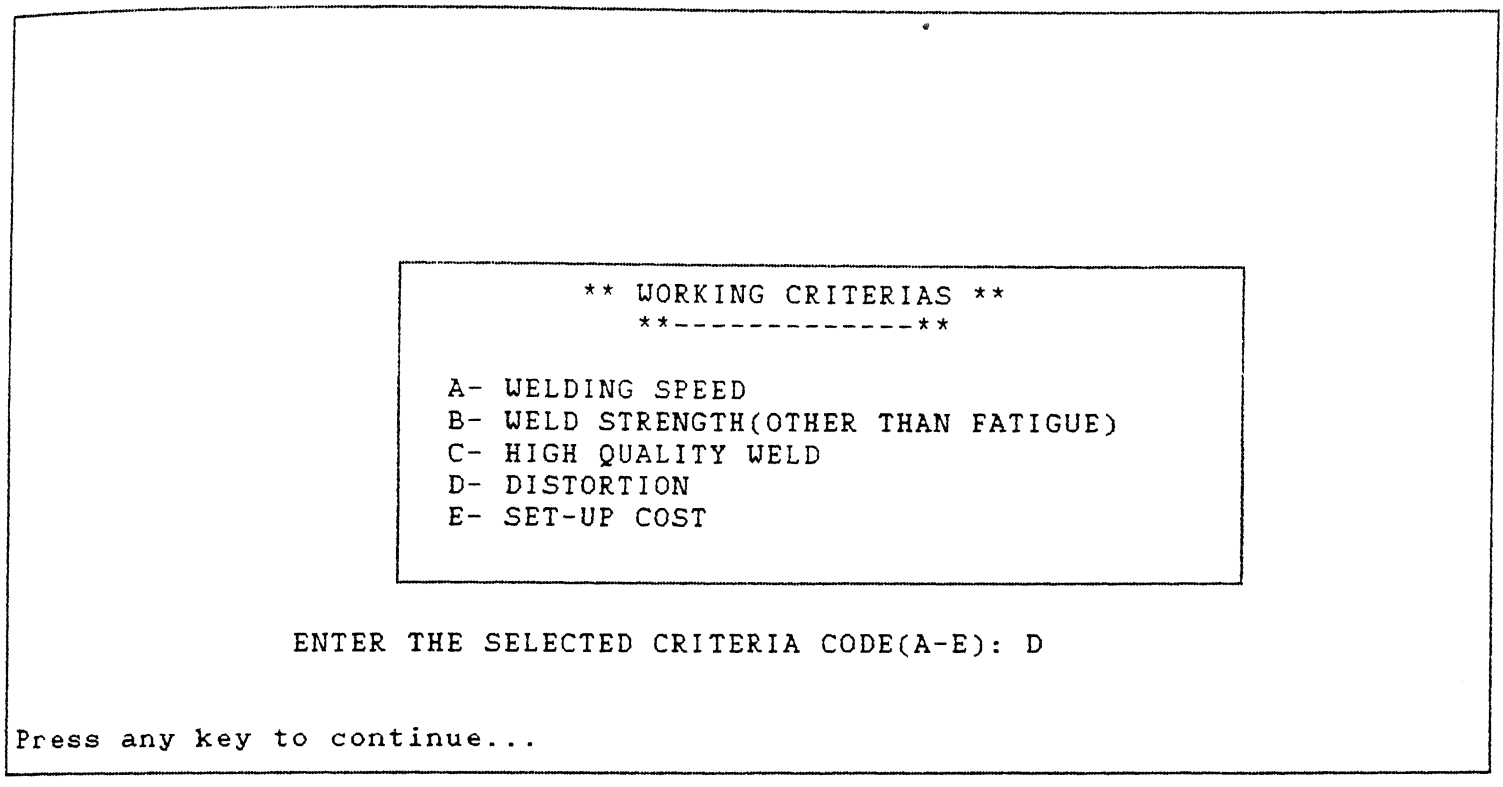


Fig. 3.15(a): XXVth Menu of WELDER for showing the list of working criteria.

```
          PROCESSES SEQUENCE, ACCORDING TO INCREASING DISTORTION
                        PROCESS(ES) FOR FILLET WELD
                        ---------------------------

        RECOMMENDED PROCESSES        LIMITED USE PROCESSES

          BRAZING
          DFW
          EBW
          FCAW
                                       NO PROCESS
                                       -AVAILABLE
                                       -AMONG
                                       -CONSIDERED
                                       -PROCESSES

    IF YOU DON'T WANT TO TRY ANOTHER WORKING CRITERIA:
         DO YOU WANT TO SELECT THE OPTIMAL PROCESS ? Y
         ENTER THE NAME OF PARTICULAR PROCESS FOR FILLET TYPE WELD ->  BRAZIN

Press any key to continue...
```

Fig. 3.15(b): XXVIth Menu of WELDER for showing the process sequence according to the selected working criteria "Distortion".

```
        OPTIMAL PROCESS FOR FILLET TYPE WELD-> BRAZING

        CAW -> Carbon Arc Welding ,DFW -> Diffusion Welding
        EBW -> Electron Beam Welding ,EGW -> Electro-Gas Welding
        ESW -> Electro-Slag Welding ,EXW -> Explosive Welding
        FCAW -> Flux-Cored Arc Welding ,FRW -> Friction Welding
        LBW -> Laser Beam Welding ,PAW ->Plasma Arc Welding
        MIG -> Metal Inert Gas Welding
        TIG -> Tungsten Inert Gas Welding
        SAW -> Submerged Arc Welding
        SMAW ->Shielded Metal Arc Welding
        USW -> Ultrasonic Welding

    FOR TAKING PRINT OUT , PRESS Print Screen KEY

Press any key to continue...
```

Fig. 3.16(a): XXVIIth Menu of WELDER for showing optimal process for suggested weld.

```
                    JOINT PREPERATION FOR THE FILLET WELD
                    *************************************
 OW          IW          G_LOWER    G_UPPER    OL_LOWER   OL_UPPER   AIL AIU BETA
PPELAPPED FILLET JOINT ( OVERLAP >= 3 TIMES THE WORKING THICKNESS (WT) )
-------------------------------------------------------------------------------
  0.75000 |999.99999|  0.00000|  0.00000|  0.00000|  0.00000|  0|  0|  0
          |         |         |         |         |         |   |   |

REMARKS:G->ROOT GAP,OW->OUTSIDE WELD SIZE,IW->INSIDE WELD SIZE,OL->OVERLAP
A1L->INCLUDED ANGLE_LOW,A1U->INCLUDED ANGLE_HIGH,BETA->OUTSIDE ANGLE
  PLEASE PRESS Print Screen KEY FOR PRINT OUT ,IN CASE YOU ARE INTERESTED

Press any key to continue...
```

Fig. 3.16(b): XXVIIIth Menu of WELDER for showing the selection of joint preparations.

```
   SELECTION OF CONSUMABLES & NONCONSUMABLES IN NEXT MODULE

Press any key to continue...
```

Fig. 3.17(a): XXIXth Menu of WELDER for showing the selection of consumables and non-consumables.

PARAMETRIC VALUES FOR FILLET TYPE WELD

OPTIMAL PROCESS : BRAZING

FILLER MATERIAL	JC_L	JC_U	BT_L	BT_U	AWS_FLUX SPECIFICATION
BCu	0.000	0.002	2000	2100	FB3D , FB3I , FB3J
RBCuZn	0.002	0.005	1670	1800	FB3D,FB3I,FB3J,FB3K
BAg	0.001	0.005	1205	1800	FB4A,FB3D,FB3I,FB3J,FB3C,B3E,B3G,B3H
BAu	0.001	0.005	1635	2250	FB3D,FB3I,FB3J
BNi	0.001	0.005	1700	2200	FB3D,FB3I,FB3J

HEATING METHOD RECOMMENDED:TORCH DIP FURNACE INDUCTION INFRARED RESISTANCE

HEATING METHOD OF LIMITED USE:NO INFORMATION

REMARKS:BT_L->BRAZING TEMP.LOWER,BT_U->BRAZING TEMP.UPPER ,TEMP. in FAREN.
JC_L->JOINT CLEARANCE LOWER, JC_U->JOINT CLEARANCE UPPER
PRESS Print Screen KEY TO TAKE PRINT OUT , IN CASE YOU ARE INTERESTED

Press any key to continue...

Fig. 3.17(b): XXXth Menu of WELDER for showing the selection of welding parameters.

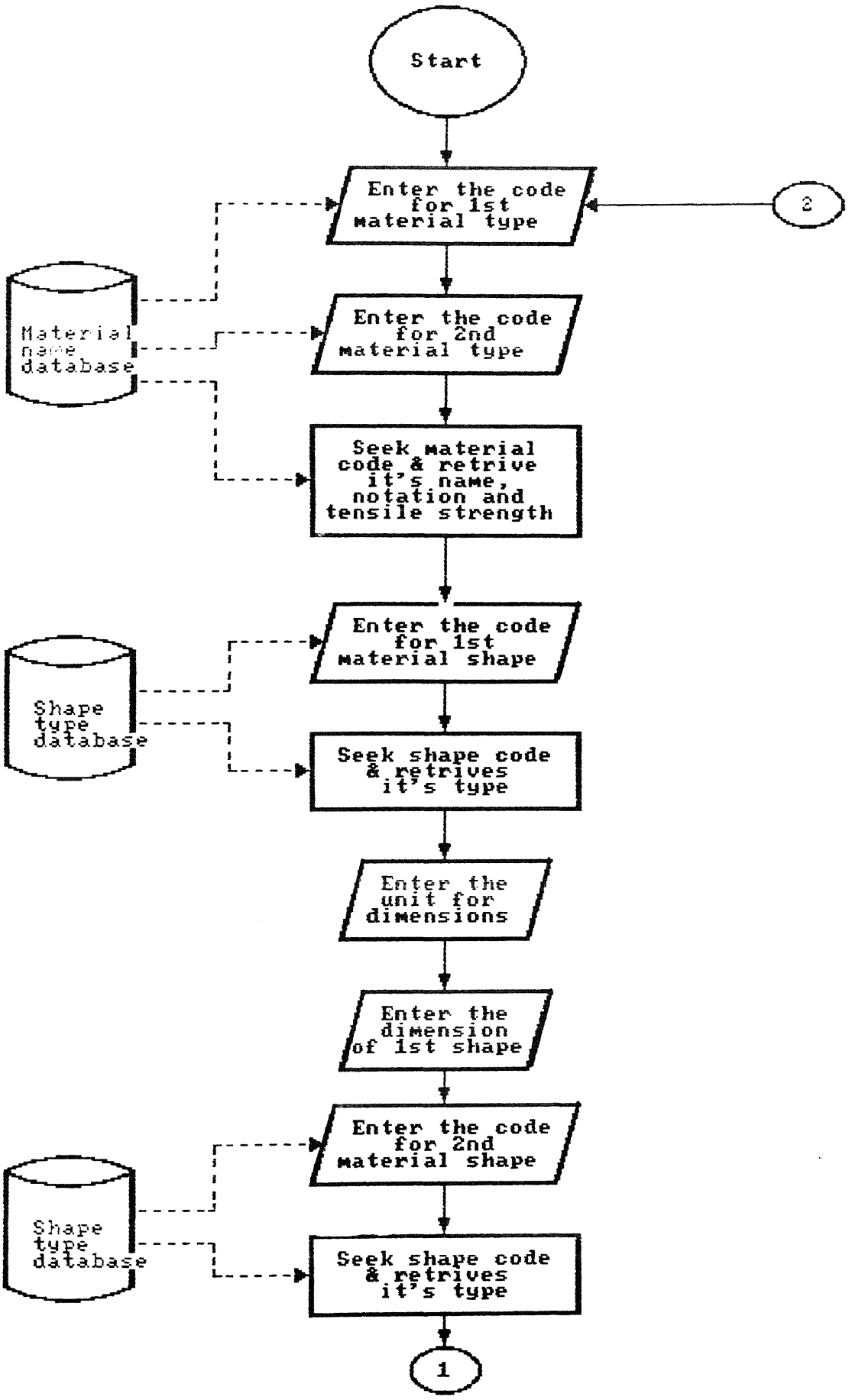
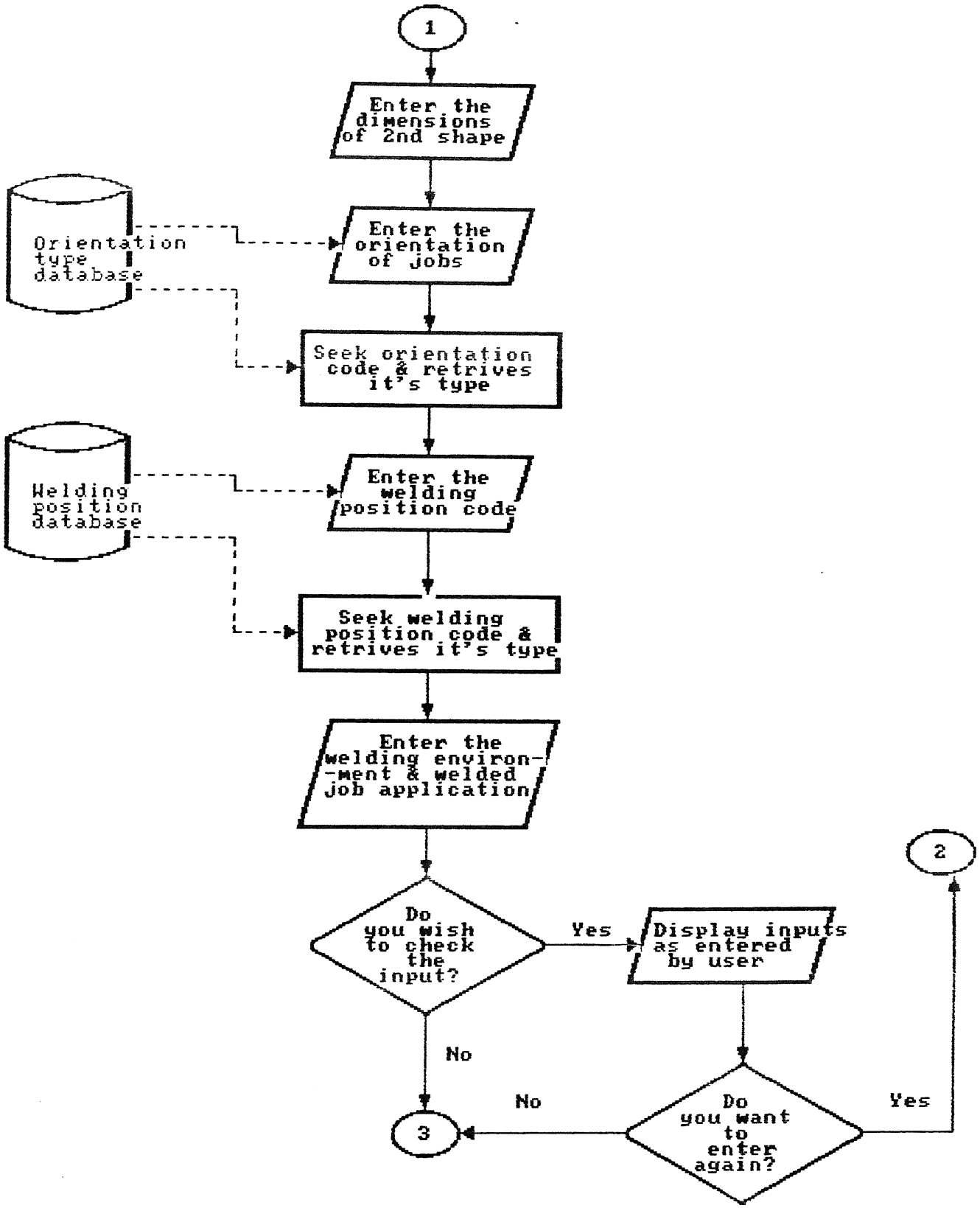
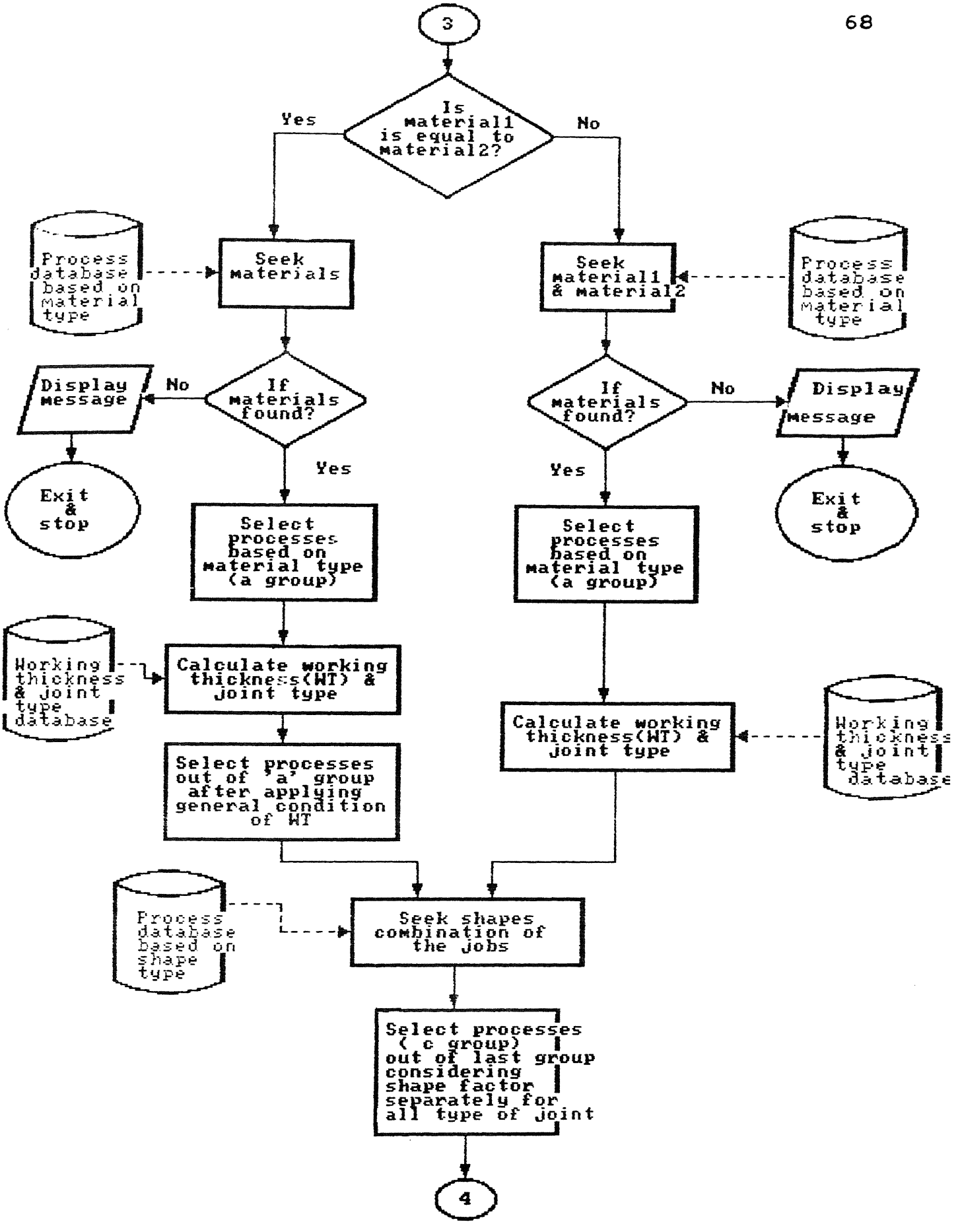
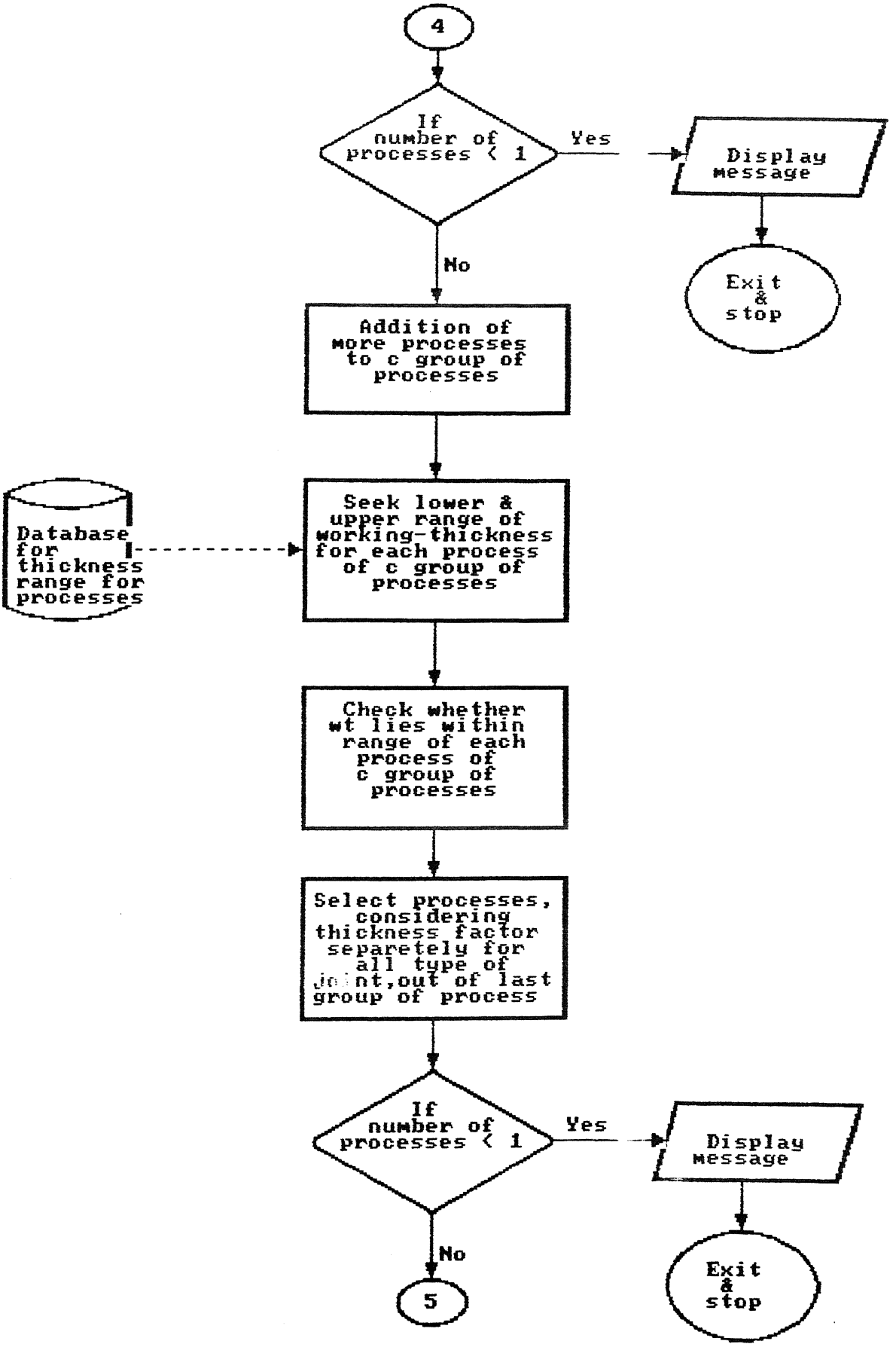
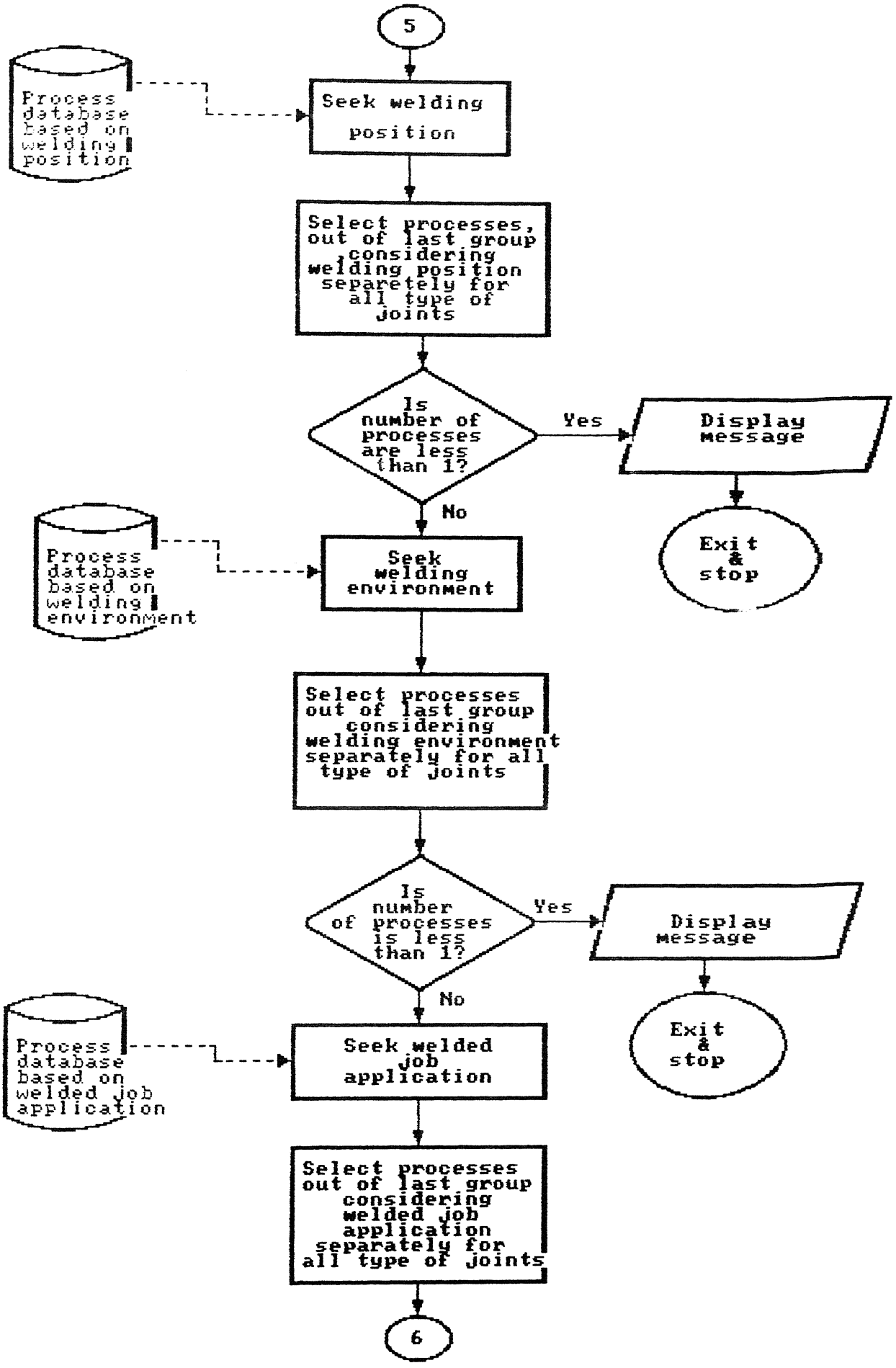


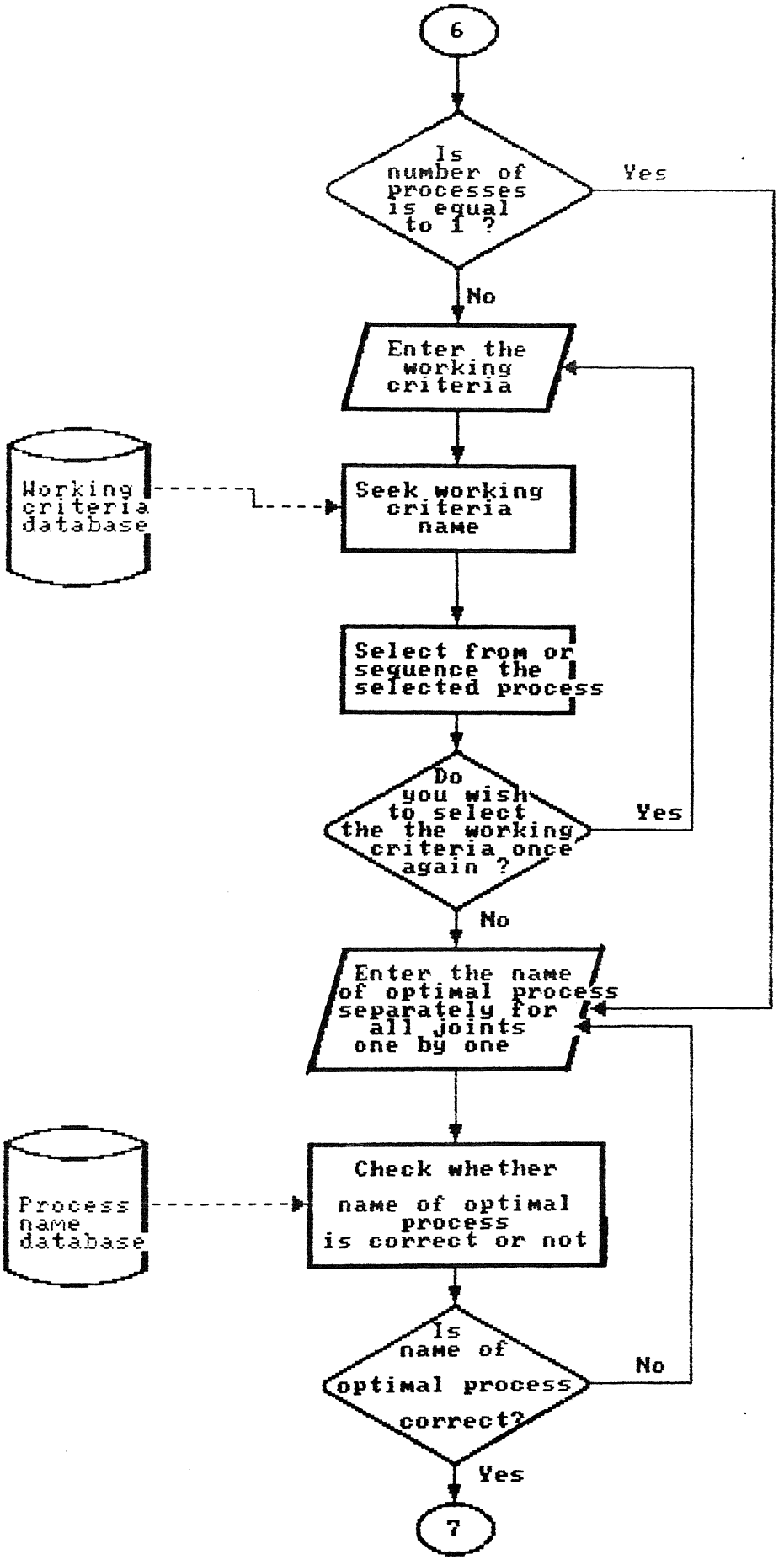
Fig. 3.18: System flow chart (Contd..)

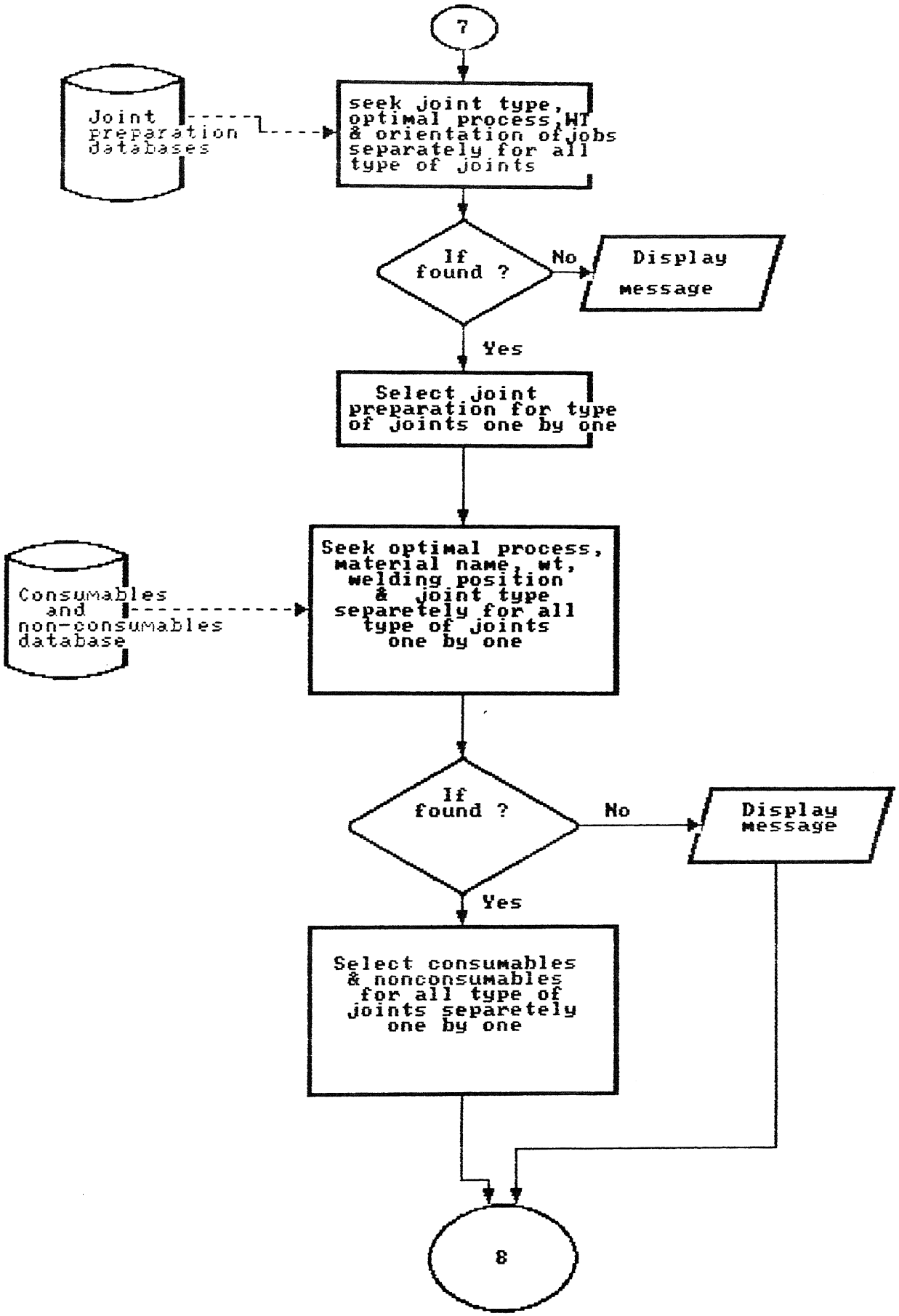

1
Enter the dimensions of 2nd shape
Orientation type database
Enter the orientation of jobs
Seek orientation code & retrives it's type
Welding position database
Enter the welding position code
Seek welding position code & retrives it's type
Enter the welding environ--ment & welded job application
Do you wish to check the input?
Yes
Display inputs as entered by user
2
No
No
Yes
3
Do you want to enter again?

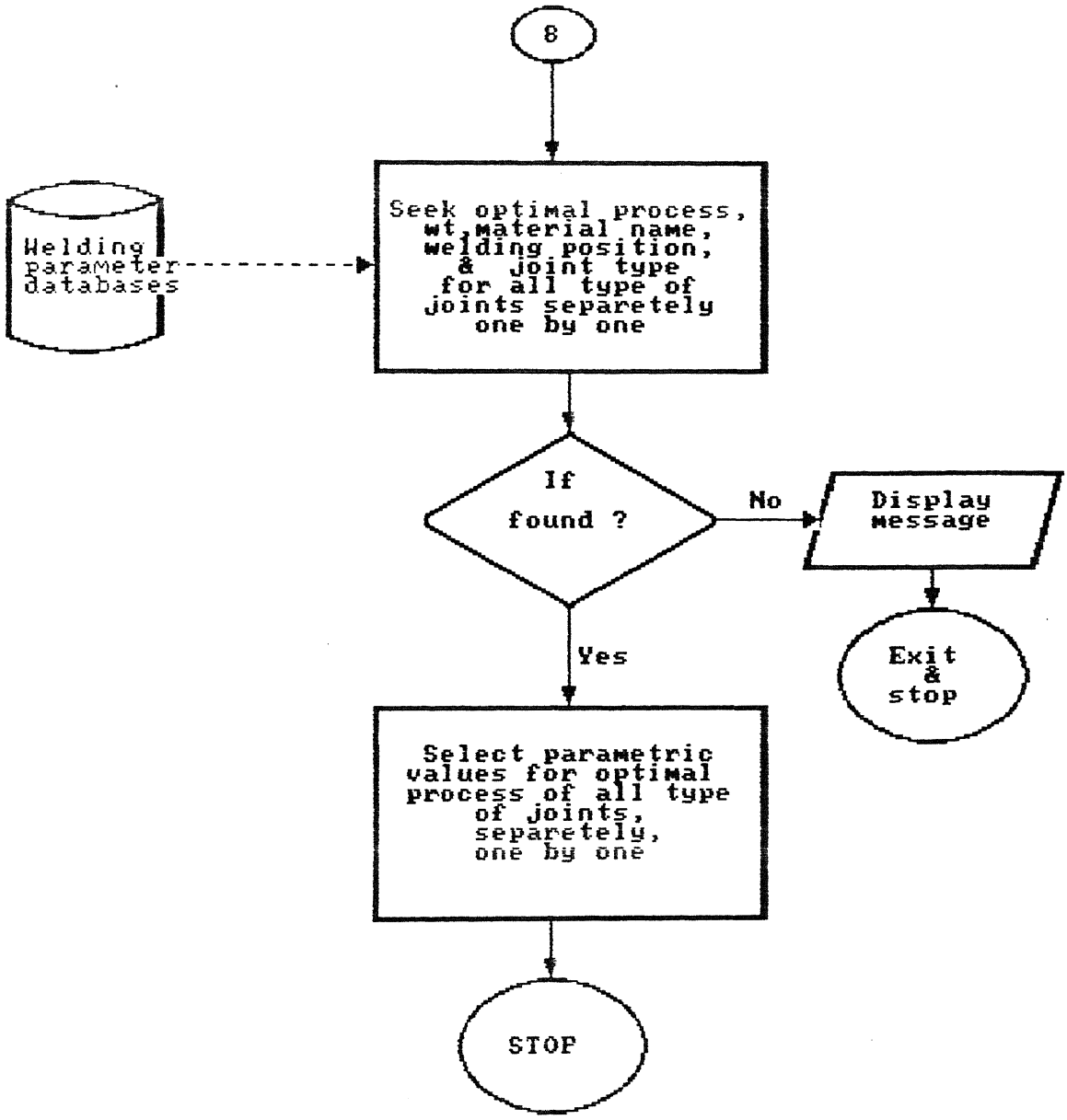

3
Is material1 is equal to material2?
Yes
No
Process database based on material type
Seek materials
Seek material1 & material2
Process database based on material type
Display message
No
If materials found?
If materials found?
No
Display message
Exit & stop
Yes
Yes
Exit & stop
Select processes based on material type (a group)
Select processes based on material type (a group)
Working thickness & joint type database
Calculate working thickness(WT) & joint type
Calculate working thickness(WT) & joint type
Working thickness & joint type database
Select processes out of 'a' group after applying general condition of WT
Process database based on shape type
Seek shapes combination of the jobs
Select processes (c group) out of last group considering shape factor separately for all type of joint
4


4
If number of processes < 1
Yes
Display message
Exit & stop
No
Addition of more processes to c group of processes
Database for thickness range for processes
Seek lower & upper range of working-thickness for each process of c group of processes
Check whether wt lies within range of each process of c group of processes
Select processes, considering thickness factor separetely for all type of joint,out of last group of process
If number of processes < 1
Yes
Display message
Exit & stop
No
5


5
Process database based on welding position
Seek welding position
Select processes, out of last group considering welding position separetely for all type of joints
Is number of processes are less than 1?
Yes
Display message
Exit & stop
No
Process database based on welding environment
Seek welding environment
Select processes out of last group considering welding environment separately for all type of joints
Is number of processes is less than 1?
Yes
Display message
Exit & stop
No
Process database based on welded job application
Seek welded job application
Select processes out of last group considering welded job application separately for all type of joints
6


6
Is number of processes is equal to 1 ?
Yes
No
Enter the working criteria
Working criteria database
Seek working criteria name
Select from or sequence the selected process
Do you wish to select the the working criteria once again ?
Yes
No
Enter the name of optimal process separately for all joints one by one
Process name database
Check whether name of optimal process is correct or not
Is name of optimal process correct?
No
Yes
7


7
Joint preparation databases
seek joint type, optimal process, WT & orientation of jobs separately for all type of joints
If found ?
No
Display message
Yes
Select joint preparation for type of joints one by one
Consumables and non-consumables database
Seek optimal process, material name, wt, welding position & joint type separetely for all type of joints one by one
If found ?
No
Display message
Yes
Select consumables & nonconsumables for all type of joints separetely one by one
8


8
Welding parameter databases
Seek optimal process, wt,material name, welding position, & joint type for all type of joints separetely one by one
If found ?
No
Display message
Exit & stop
Yes
Select parametric values for optimal process of all type of joints, separetely, one by one
STOP

DATABASE SYSTEM FLOW CHART

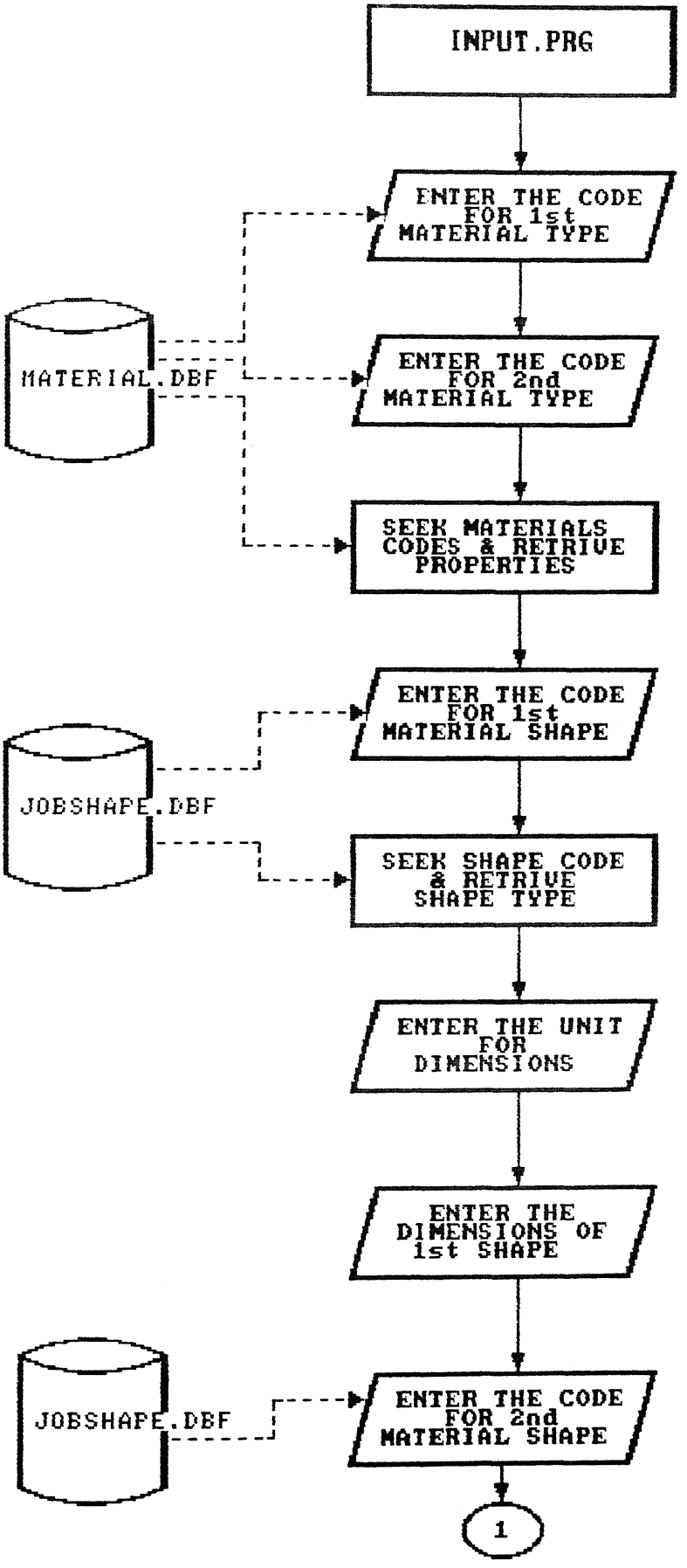
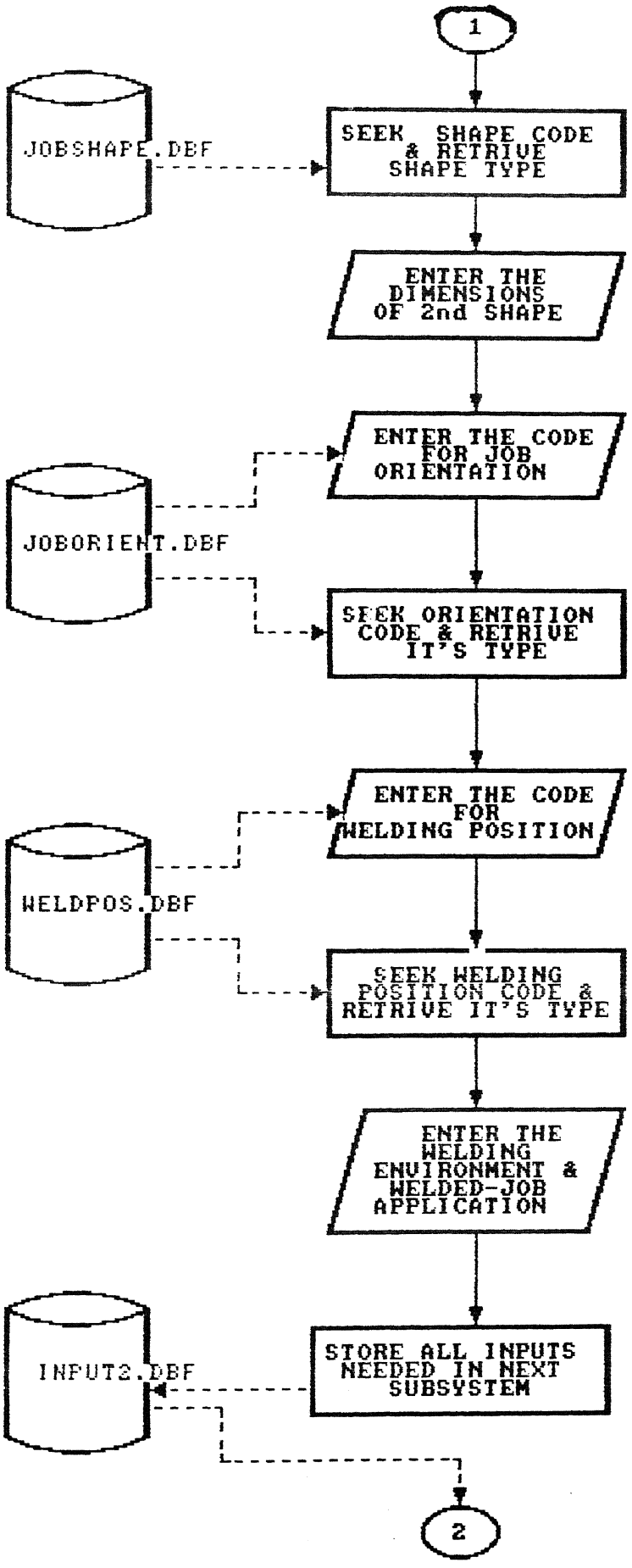
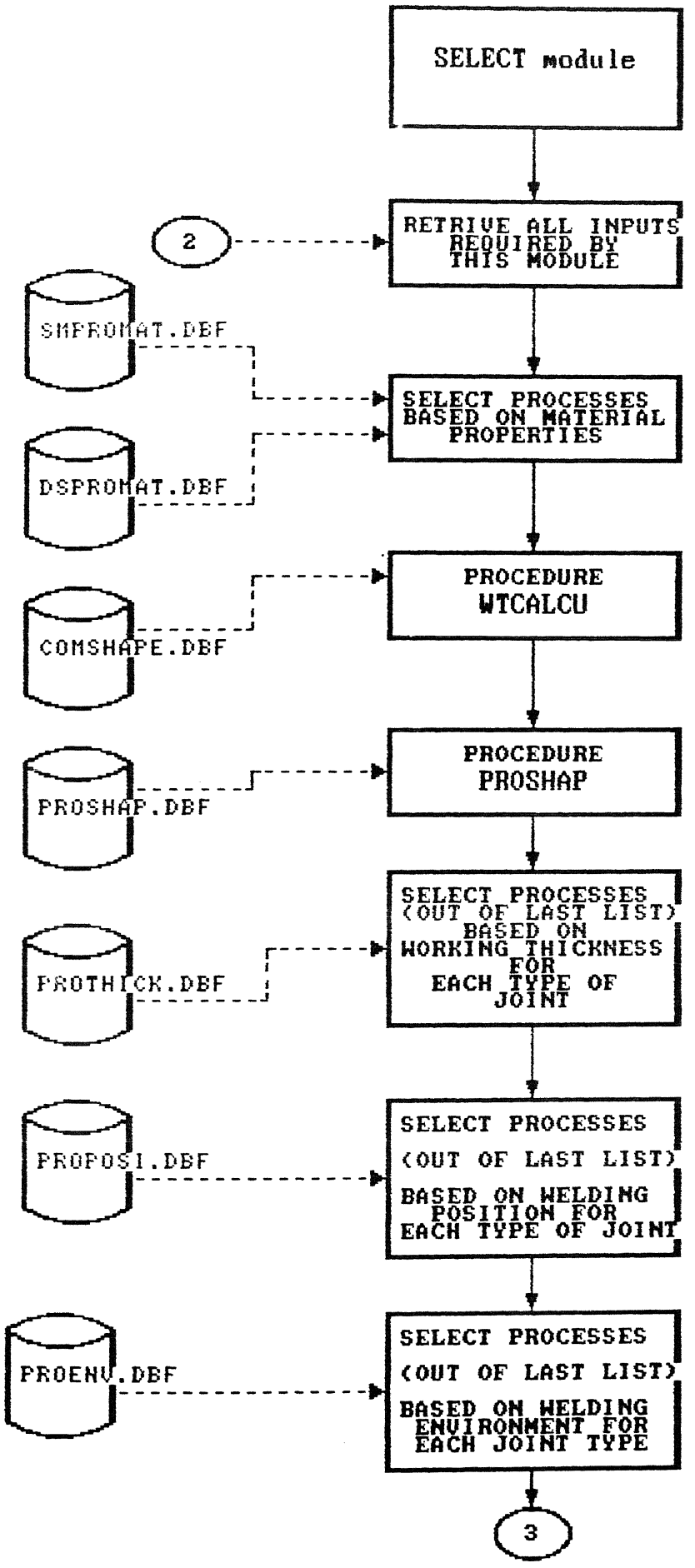


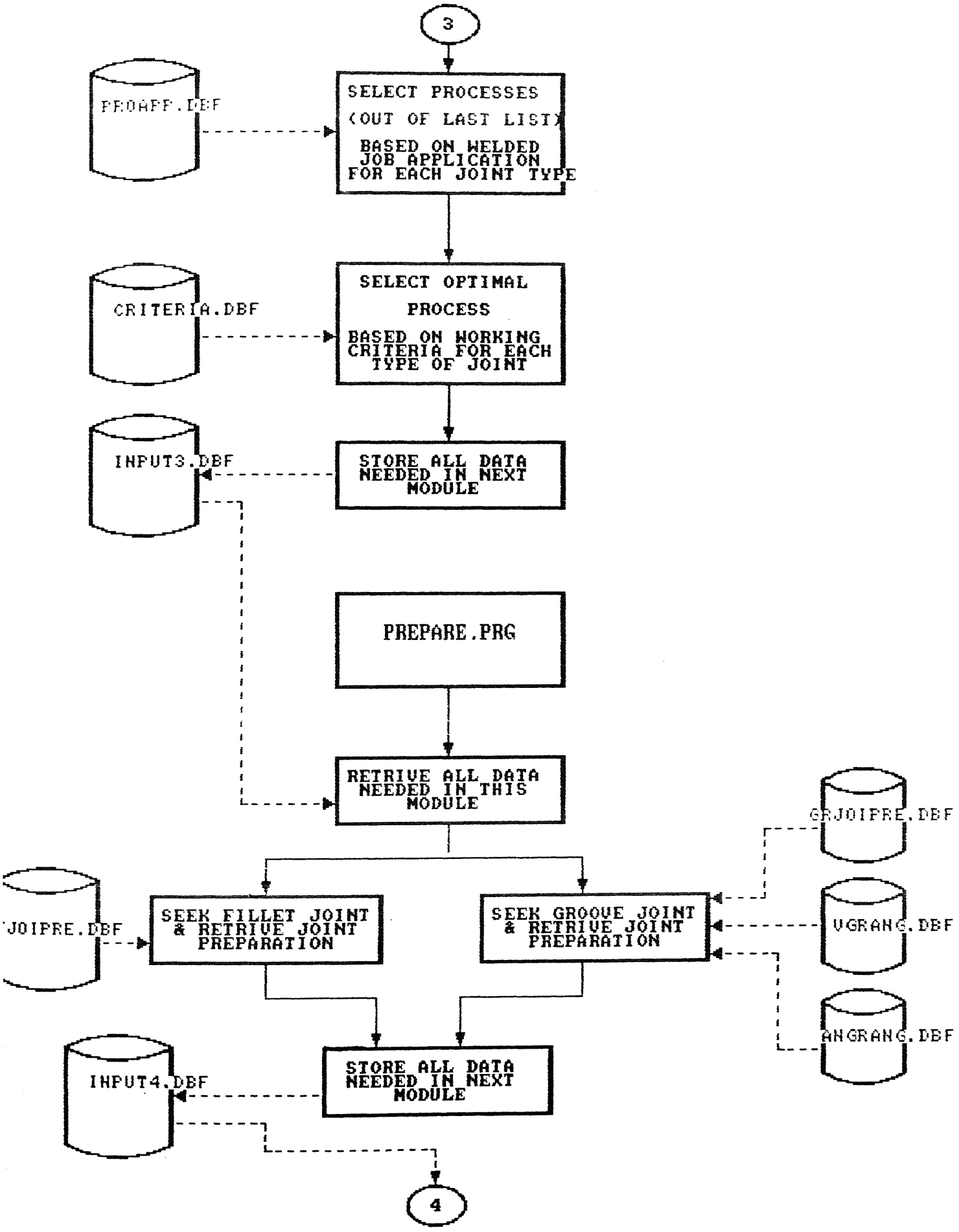
Fig. 3.19: Data-base flow chart.

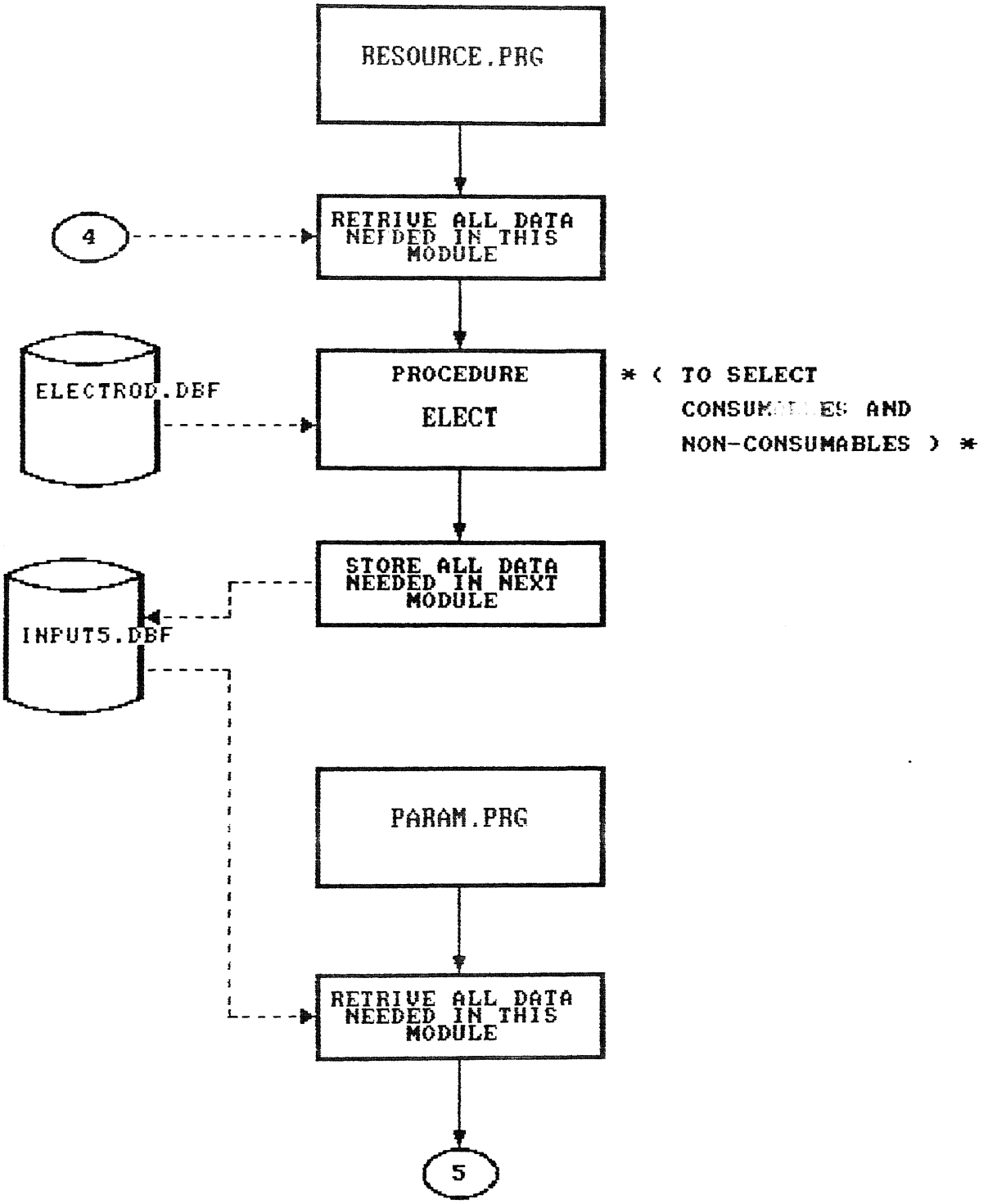

1
JOBSHAPE.DBF
SEEK SHAPE CODE & RETRIVE SHAPE TYPE
ENTER THE DIMENSIONS OF 2nd SHAPE
ENTER THE CODE FOR JOB ORIENTATION
JOBORIENT.DBF
SEEK ORIENTATION CODE & RETRIVE IT'S TYPE
ENTER THE CODE FOR WELDING POSITION
WELDPOS.DBF
SEEK WELDING POSITION CODE & RETRIVE IT'S TYPE
ENTER THE WELDING ENVIRONMENT & WELDED-JOB APPLICATION
INPUT2.DBF
STORE ALL INPUTS NEEDED IN NEXT SUBSYSTEM
2

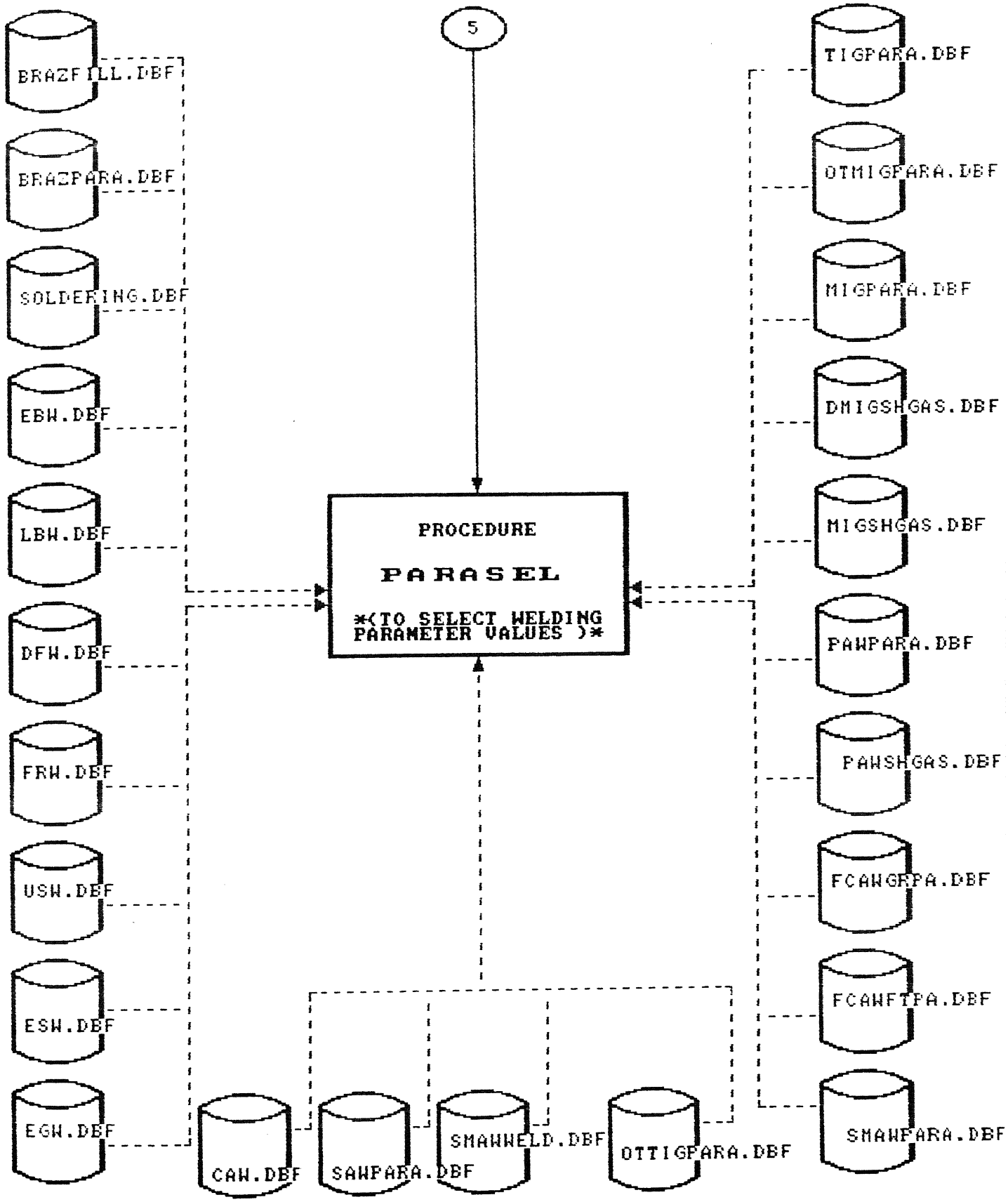


* (TO CLCULATE WORKING THICKNESS & JOINT TYPE) *

* (SELECT PROCESSES, OUT OF LAST LIST, BASED ON SHAPES & JOINT TYPE) *


3
PROAPP.DBF
SELECT PROCESSES
(OUT OF LAST LIST)
BASED ON WELDED
JOB APPLICATION
FOR EACH JOINT TYPE
CRITERIA.DBF
SELECT OPTIMAL
PROCESS
BASED ON WORKING
CRITERIA FOR EACH
TYPE OF JOINT
INPUT3.DBF
STORE ALL DATA
NEEDED IN NEXT
MODULE
PREPARE.PRG
RETRIVE ALL DATA
NEEDED IN THIS
MODULE
GRJOIPRE.DBF
JOIPRE.DBF
SEEK FILLET JOINT
& RETRIVE JOINT
PREPARATION
SEEK GROOVE JOINT
& RETRIVE JOINT
PREPARATION
VGRANG.DBF
ANGRANG.DBF
INPUT4.DBF
STORE ALL DATA
NEEDED IN NEXT
MODULE
4


RESOURCE.PRG
4
RETRIVE ALL DATA NEEDED IN THIS MODULE
ELECTROD.DBF
PROCEDURE
ELECT
* (TO SELECT
CONSUMABLES AND
NON-CONSUMABLES) *
STORE ALL DATA NEEDED IN NEXT MODULE
INPUT5.DBF
PARAM.PRG
RETRIVE ALL DATA NEEDED IN THIS MODULE
5


5
BRAZFILL.DBF
BRAZPARA.DBF
SOLDERING.DBF
EBW.DBF
LBW.DBF
DFW.DBF
FRW.DBF
USW.DBF
ESW.DBF
EGW.DBF
PROCEDURE
PARASEL
(TO SELECT WELDING PARAMETER VALUES)
CAW.DBF
SAWPARA.DBF
SMAWWELD.DBF
OTTIGPARA.DBF
TIGPARA.DBF
OTMIGPARA.DBF
MIGPARA.DBF
DMIGSHGAS.DBF
MIGSHGAS.DBF
PAWPARA.DBF
PAWSHGAS.DBF
FCAWGPPA.DBF
FCAWFTPA.DBF
SMAWPARA.DBF

Chapter 4

RESULTS and DISCUSSION

In this chapter, few examples have been discussed alongwith their results presented in the form of screen printouts. The examples considered are as follows :

Example 1 :

Input for WELDER :

Input type	Option selected	Code
Ist material name	Aluminium	39
IInd material name	Aluminium	39
Ist job shape	Sheet	1
Unit for dimensions	inch	1
Thickness of the sheet (t_1)	0.5 inch	
IInd job shape	Sheet	1
Thickness of the sheet (t_2)	0.62 inch	
Orientation of the jobs	Longitudinal Butt joint	1
Welding position	Overhead	4
Welding environment	Indoor	
Welded job application	Fatigue loading	

Output from WELDER :

The output obtained from the WELDER are shown in Figure 4.1a, 4.1b, 4.1c, 4.1d and 4.1e.

Discussion:

In this example, an optimal process has been selected on the basis of 'Weld strength', a desired working criteria. The selection of optimal process can also be done based on other working criteria. Regarding the welding speed, high quality weld and distortion working criteria, the optimal process would be EXW. The WELDER has suggested groove type of joint. For entered combination of inputs, the system has recommended two sets of welding parameters for optimal process from which any one can be used.

```
TYPE OF POSSIBLE JOINT FOR THE WELDING

        GROOVE TYPE

Press any key to continue...
```

Fig. 4.1a: First WELDER output for example 1.

```
OPTIMAL PROCESS FOR ADVISED WELD-> MIG_SPRAY

CAW -> Carbon Arc Welding ,DFW -> Diffusion Welding
EBW -> Electron Beam Welding ,EGW -> Electro-Gas Welding
ESW -> Electro-Slag Welding ,EXW -> Explosive Welding
FCAW -> Flux-Cored Arc Welding ,FRW -> Friction Welding
LBW -> Laser Beam Welding ,PAW ->Plasma Arc Welding
MIG -> Metal Inert Gas Welding
TIG -> Tungsten Inert Gas Welding
SAW -> Submerged Arc Welding ,
SMAW ->Shielded Metal Arc Welding
USW -> Ultrasonic Welding

FOR TAKING PRINT OUT , PRESS Print Screen KEY

Press any key to continue...
```

Fig. 4.1b: Second WELDER putput for example 1.

```
                    JOINT PREPERATION FOR THE GROOVE WELD
 F_LOWER    F_UPPER    G_LOWER    G_UPPER    RADIUS     A1L A1U A2L  A2U  BL   BU
-------------------------------------------------------------------------------
SINGLE GROOVE WELDING FROM BOTH SIDE
 SINGLE V GROOVE
  0.00000 |  0.12500|  0.09375|  0.12500|  0.00000|  80 100   0|  0   0   0
 SINGLE BEVEL GROOVE
  0.00000 |  0.12500|  0.00000|  0.12500|  0.00000|  45  50   0|  0   0   0
 SINGLE U GROOVE
  0.06250 |  0.18750|  0.00000|  0.09375|  0.25000|  45  50   0|  0   0   0
 SINGLE J GROOVE
  0.06250 |  0.18750|  0.00000|  0.09375|  0.50000|  35  50   0|  0   0   0
          |         |         |         |         |   |   |    |     |   |


 REMARK:F->ROOT FACE,G->ROOT GAP,RADIUS->ROOT RAD.,BL->BETA_LOW,BU->BETA_HIGH
 A1L-INC.ANGLE1_LOW,A1U-INC.ANGLE1_HIGH,A2L-INC.ANGLE2_LOW,A2U-INC.ANGLE2_HIGH
  PLEASE PRESS Print Screen KEY FOR PRINT OUT ,IN CASE YOU ARE INTERESTED

Press any key to continue...
```

Fig. 4.1c: Third WELDER output for example 1.

```
                        **SELECTION OF ELECTRODE**

          OPTIMAL PROCESS:  MIG_SPRAY


 AWS_FILLER MATERIAL SPECIFICATION:     ER-1100 , ER-A1_2




   PRESS Print Screen KEY TO TAKE PRINT OUT, IN CASE YOU ARE INTERESTED

Press any key to continue...
```

Fig. 4.1d: Fourth WELDER output for example 1.

PARAMETRIC VALUES FOR GROOVE TYPE WELD

OPTIMAL PROCESS : MIG_SPRAY

W.THICK	FILLER MATERIAL_DIA	POLARITY	CURRENT	VOLTAGE	FM_FDR	GFR	NOP	TRS
0.50000	0.06250	DCEP(RP)	220-230	22-27	195-205	40	3-8	12-18
0.50000	0.09375	DCEP(RP)	320-340	22-29	140-150	45	2-5	15-17

SHIELDING GAS(es) :ARGON

REMARKS:W.THICK >WORKING THICKNESS,FM_FDR->FILLER MATERIAL FEED RATE(inch/min)GFR->GAS FLOW RATE(cu.ft./hr),NOP->No. OF PASSES,TRS->TRAVEL SPEED(inch/min)

PRESS Print Screen KEY TO TAKE PRINT OUT , IN CASE YOU ARE INTERESTED

Press any key to continue...

Fig. 4.1e: Fifth WELDER output for example 1.

Example 2 :

Input for WELDER :

Input type	Option selected	Code
Ist material name	Tool steel	4
IInd material name	Tool steel	4
Ist job shape	Sheet	1
Unit for dimensions	inch	1
Thickness of the sheet (t_1)	0.25 inch	
IInd job shape	Tube	3
Outer diameter of tube (d_2)	2.0 inch	
Thickness of the tube (t_2)	0.75 inch	
Orientation of the jobs	Corner joint	4
Welding position	Vertical	3
Welding environment	Outdoor	
Welded job application	Steady loading	

Output from WELDER :

The output obtained from the WELDER are shown in Figure 4.2a, 4.2b, 4.2c, 4.2d, 4.2e, 4.2f, 4.2g, 4.2h and 4.2i.

Discussion:

The WELDER has suggested groove and fillet type of joints for this set of inputs. Brazing is an optimal process in the recommended group on the basis of desired working criteria as 'High quality weld'. For remaining working criteria, except 'Welding speed', brazing is the only option for the optimal process in the recommended group. For brazing like processes, consumable selection has been done in PARAM subsystem alongwith the welding parameters selection. The WELDER has suggested some consumables and welding parameters for both type of joints because these selections are dependent upon type of materials, not

on working thickness.

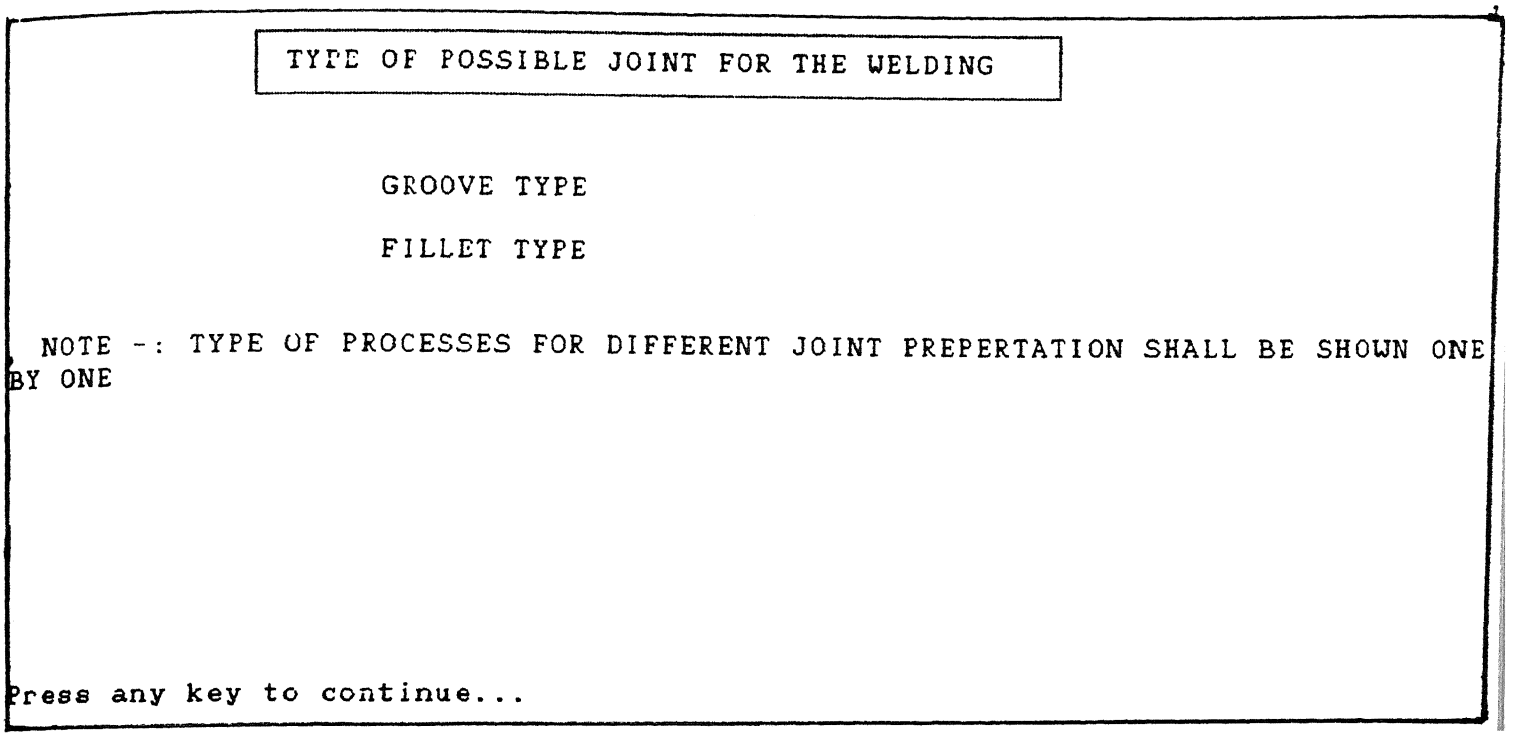


Fig. 4.2a: First WELDER output for example 2.

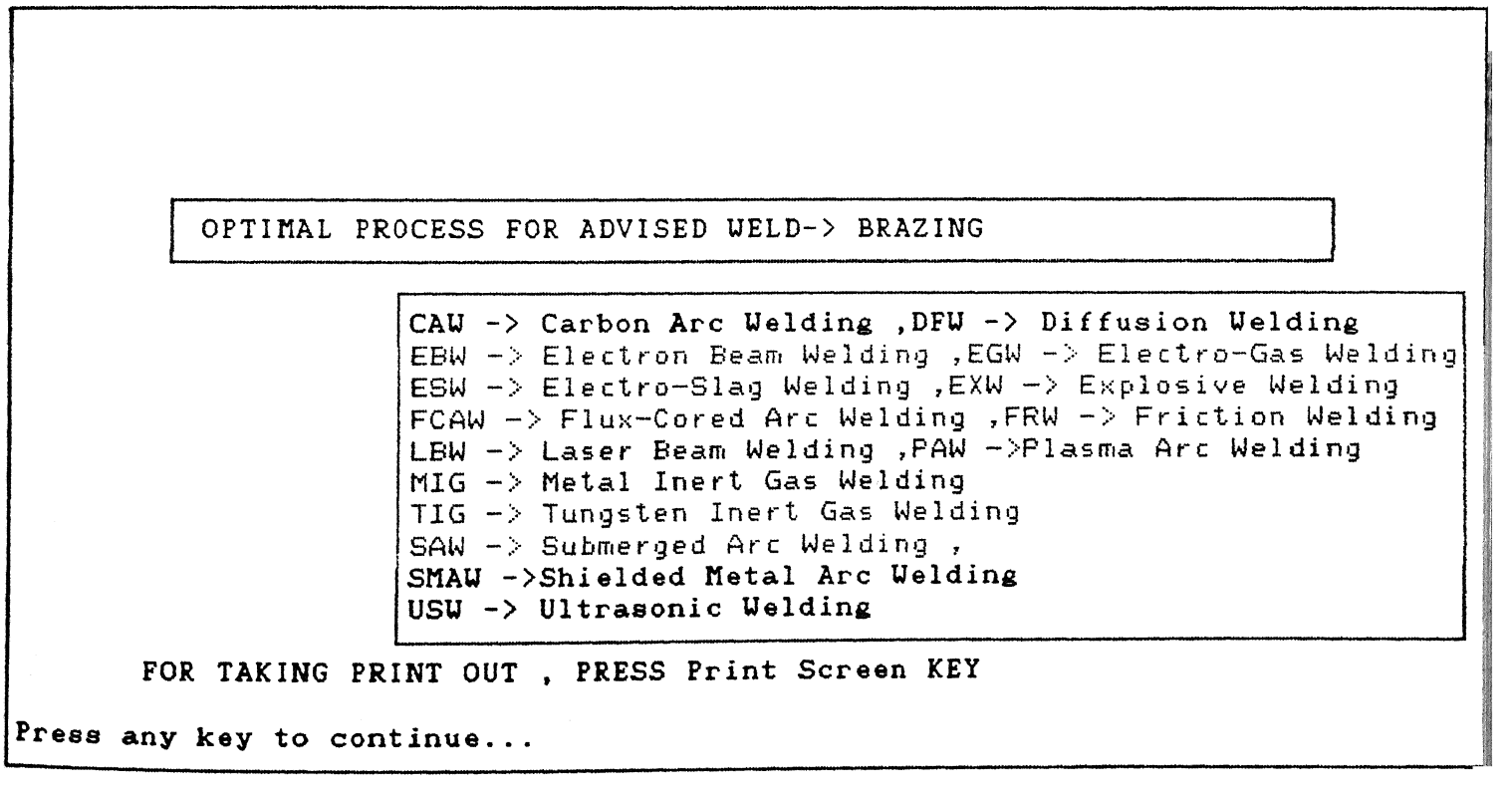


Fig. 4.2b: Second WELDER output for example 2.

```
OPTIMAL PROCESS FOR FILLET TYPE WELD-> BRAZING

CAW -> Carbon Arc Welding ,DFW -> Diffusion Welding
EBW -> Electron Beam Welding ,EGW -> Electro-Gas Welding
ESW -> Electro-Slag Welding ,EXW -> Explosive Welding
FCAW -> Flux-Cored Arc Welding ,FRW -> Friction Welding
LBW -> Laser Beam Welding ,PAW ->Plasma Arc Welding
MIG -> Metal Inert Gas Welding
TIG -> Tungsten Inert Gas Welding
SAW -> Submerged Arc Welding
SMAW ->Shielded Metal Arc Welding
USW -> Ultrasonic Welding

FOR TAKING PRINT OUT , PRESS Print Screen KEY

Press any key to continue...
```

Fig. 4.2c: Third WELDER output for example 2.

```
                    JOINT PREPERATION FOR THE GROOVE WELD
 F_LOWER    F_UPPER    G_LOWER    G_UPPER    RADIUS     A1L A1U A2L  A2U  BL   BU
-------------------------------------------------------------------------------
SINGLE GROOVE WELDING FROM ONE SIDE WITHOUT BACKING STRIP
 SQUARE GROOVE (RARELY USED)
  0.00000 |  0.00000|  0.00000|  0.00000|  0.00000|   0   0   0|  0   0   0
SINGLE GROOVE WELDING FROM BOTH SIDE     |         |   |   |   |    |   |
 SQUARE GROOVE (RARELY USED)
  0.00000 |  0.00000|  0.00000|  0.00000|  0.00000|   0   0   0|  0   0   0
          |         |         |         |         |   |   |   |    |   |
 REMARK:F->ROOT FACE,G->ROOT GAP,RADIUS->ROOT RAD.,BL->BETA_LOW,BU->BETA_HIGH
 A1L-INC.ANGLE1_LOW,A1U-INC.ANGLE1_HIGH,A2L-INC.ANGLE2_LOW,A2U-INC.ANGLE2_HIGH
  PLEASE PRESS Print Screen KEY FOR PRINT OUT ,IN CASE YOU ARE INTERESTED

Press any key to continue...
```

Fig. 4.2d: Fourth WELDER output for example 2.

```
                    JOINT PREPERATION FOR THE FILLET WELD
                    *************************************
 OW          IW          G_LOWER    G_UPPER    OL_LOWER   OL_UPPER   AIL AIU BETA

PRELAPPED FILLET JOINT ( OVERLAP >= 3 TIMES THE WORKING THICKNESS (WT) )
-------------------------------------------------------------------------------
  0.56250 |999.99999|  0.00000|  0.00000|  0.00000|  0.00000|  0|  0|  0
          |         |         |         |         |         |   |   |

REMARKS:G->ROOT GAP,OW->OUTSIDE WELD SIZE,IW->INSIDE WELD SIZE,OL->OVERLAP
A1L->INCLUDED ANGLE_LOW,A1U->INCLUDED ANGLE_HIGH,BETA->OUTSIDE ANGLE
  PLEASE PRESS Print Screen KEY FOR PRINT OUT ,IN CASE YOU ARE INTERESTED

Press any key to continue...
```

Fig. 4.2e: Fifth WELDER output for example 2.

```
SELECTION OF CONSUMABLES & NONCONSUMABLES IN NEXT MODULE
```

```
Press any key to continue...
```

Fig. 4.2f & g: Sixth & Seventh WELDER output for example 2.

PARAMETRIC VALUES FOR GROOVE TYPE WELD

OPTIMAL PROCESS : BRAZING

FILLER MATERIAL	JC_L	JC_U	BT_L	BT_U	AWS_FLUX SPECIFICATION
BCu	0.000	0.002	2000	2100	FB3D , FB3I , FB3J
RBCuZn	0.002	0.005	1670	1800	FB3D,FB3I,FB3J,FB3K
BAg	0.001	0.005	1205	1800	FB4A,FB3D,FB3I,FB3J,FB3C,B3E,B3G,B3H
BAu	0.001	0.005	1635	2250	FB3D,FB3I,FB3J
BNi	0.001	0.005	1700	2200	FB3D,FB3I,FB3J

HEATING METHOD RECOMMENDED:FURNACE

HEATING METHOD OF LIMITED USE:DIP INDUCTION RESISTANCE

REMARKS:BT_L->BRAZING TEMP.LOWER,BT_U->BRAZING TEMP.UPPER ,TEMP. in FAREN.
JC_L->JOINT CLEARANCE LOWER, JC_U->JOINT CLEARANCE UPPER
PRESS Print Screen KEY TO TAKE PRINT OUT , IN CASE YOU ARE INTERESTED

Press any key to continue...

Fig. 4.2h: Eight WELDER output for example 2.

PARAMETRIC VALUES FOR FILLET TYPE WELD

OPTIMAL PROCESS : BRAZING

FILLER MATERIAL	JC_L	JC_U	BT_L	BT_U	AWS_FLUX SPECIFICATION
BCu	0.000	0.002	2000	2100	FB3D , FB3I , FB3J
RBCuZn	0.002	0.005	1670	1800	FB3D,FB3I,FB3J,FB3K
BAg	0.001	0.005	1205	1800	FB4A,FB3D,FB3I,FB3J,FB3C,B3E,B3G,B3H
BAu	0.001	0.005	1635	2250	FB3D,FB3I,FB3J
BNi	0.001	0.005	1700	2200	FB3D,FB3I,FB3J

HEATING METHOD RECOMMENDED:FURNACE

HEATING METHOD OF LIMITED USE:DIP INDUCTION RESISTANCE

REMARKS:BT_L->BRAZING TEMP.LOWER,BT_U->BRAZING TEMP.UPPER ,TEMP. in FAREN.
JC_L->JOINT CLEARANCE LOWER, JC_U->JOINT CLEARANCE UPPER
PRESS Print Screen KEY TO TAKE PRINT OUT , IN CASE YOU ARE INTERESTED

ress any key to continue...

Fig. 4.2i: Ninth WELDER output for example 2.

Example 3 :

Input for WELDER :

Input type	Option selected	Code
Ist material name	Tungsten	112
IInd material name	Tungsten	112
Ist job shape	Sheet	1
Unit for dimensions	cm	2
Thickness of the sheet (t_1)	0.35 cm	
IInd job shape	Sheet	1
Thickness of the sheet (t_2)	2.54 cm	
Orientation of the jobs	Angular joint	5
Included angle between jobs	60^o	
Welding position	Flat	1
Welding environment	Indoor	
Welded job application	Fatigue loading	

Output from WELDER :

The output obtained from the WELDER are shown in Figure 4.3a, 4.3b, 4.3c, 4.3d, 4.3e, 4.3f, 4.3g, 4.3h and 4.3i.

Discussion:

Both type of joints have been suggested taking in account the combination of shapes with an orientation. An optimal process for groove type joint has been obtained while implementing 'Welding speed' working criteria. The optimal process for fillet type joint has been shortlisted on the basis first five governing considerations (as discussed in section 3.4). For fillet type weld for DFW, no preparation is needed. The consumable selection has been done in PARAM subsystem for both type of processes. Due to non-availability of exact data for EBW, the proper combination of welding parameters has been suggested.

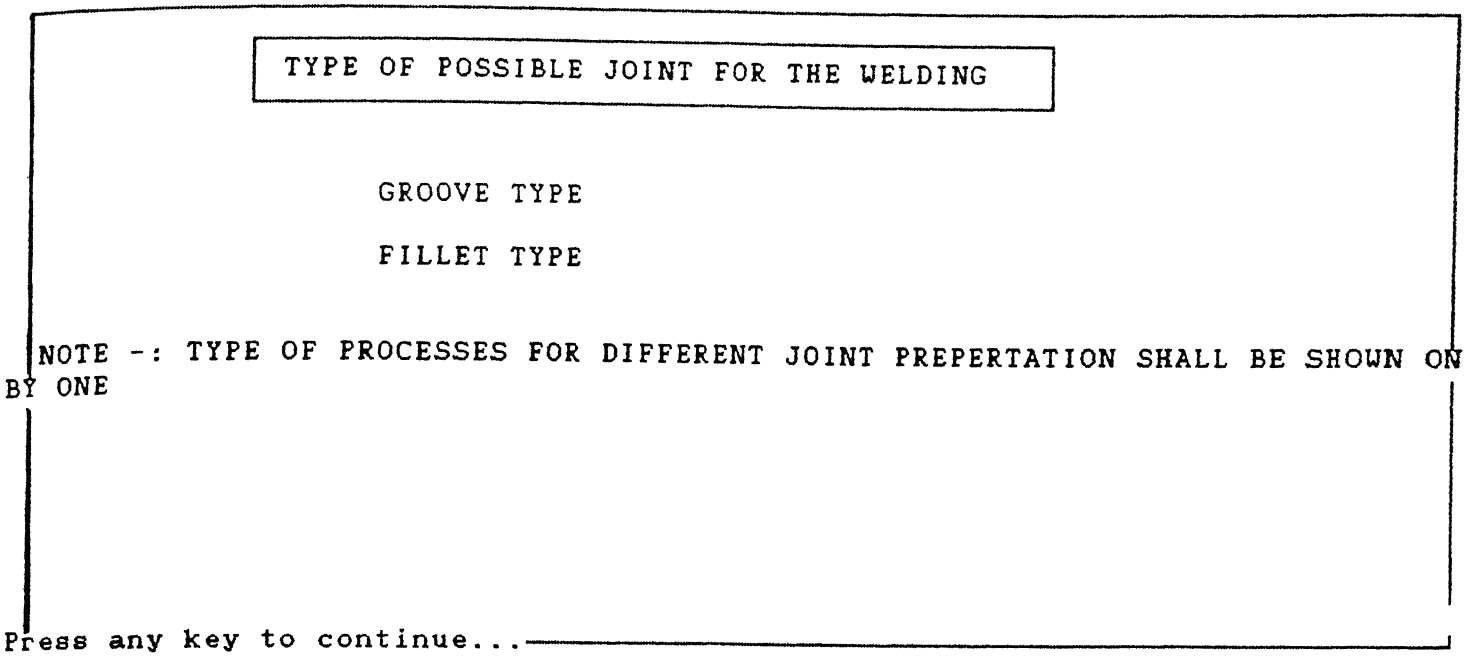


Fig. 4.3a: First WELDER output for example 3.

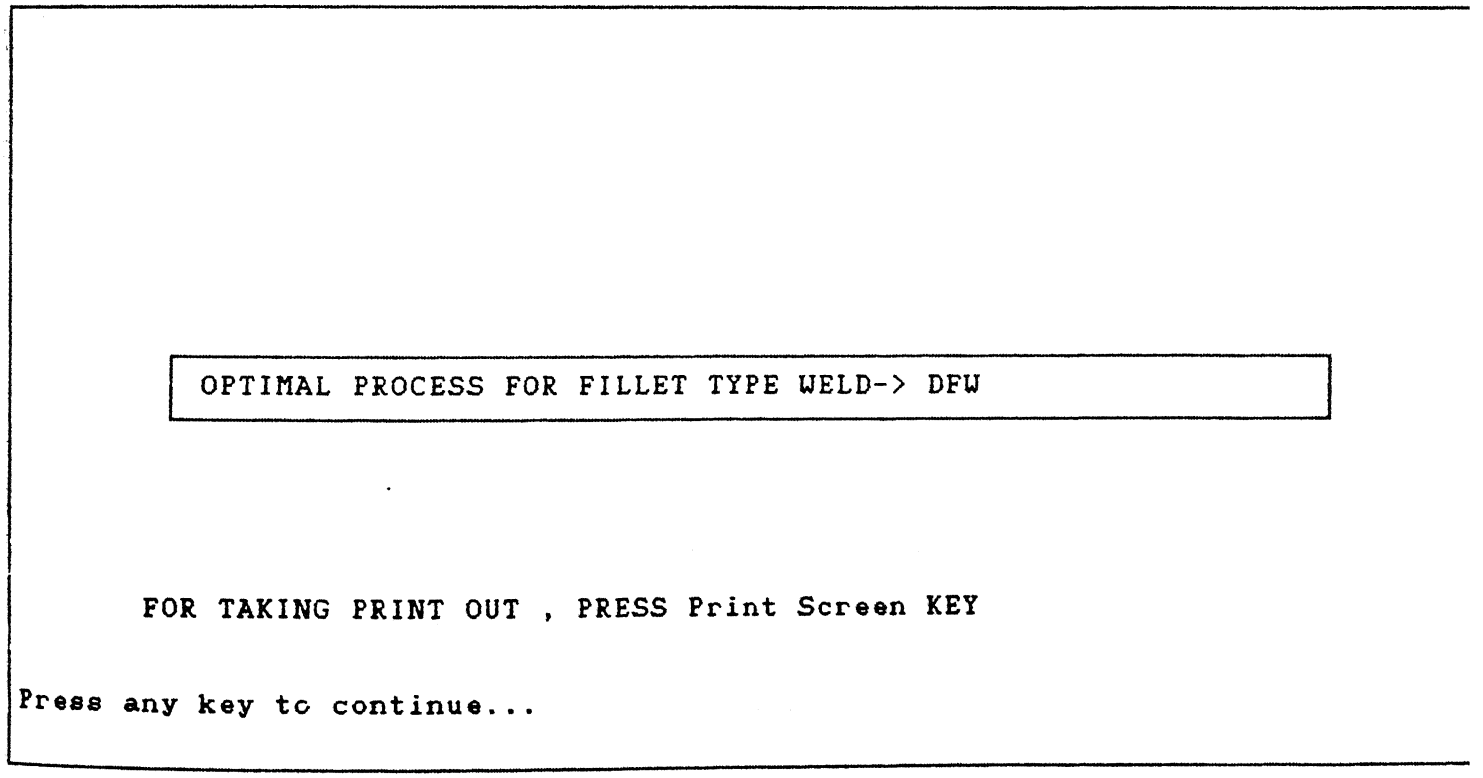


Fig. 4.3b: Second WELDER output for example 3.

```
OPTIMAL PROCESS FOR ADVISED WELD-> EBW

CAW -> Carbon Arc Welding ,DFW -> Diffusion Welding
EBW -> Electron Beam Welding ,EGW -> Electro-Gas Welding
ESW -> Electro-Slag Welding ,EXW -> Explosive Welding
FCAW -> Flux-Cored Arc Welding ,FRW -> Friction Welding
LBW -> Laser Beam Welding ,PAW ->Plasma Arc Welding
MIG -> Metal Inert Gas Welding
TIG -> Tungsten Inert Gas Welding
SAW -> Submerged Arc Welding ,
SMAW ->Shielded Metal Arc Welding
USW -> Ultrasonic Welding

FOR TAKING PRINT OUT , PRESS Print Screen KEY

Press any key to continue...
```

Fig. 4.3c: Third WELDER output for example 3.

```
                    JOINT PREPERATION FOR THE GROOVE WELD
 F_LOWER    F_UPPER    G_LOWER    G_UPPER    RADIUS     A1L A1U A2L  A2U  BL   BU
SINGLE GROOVE WELDING FROM BOTH SIDE
 SQUARE GROOVE
  0.00000 |  0.00000|  0.00300|  0.01000|  0.00000|    0   0   0|  0   0   0
          |         |         |         |         |    |   |    |      |    |

 REMARK:F->ROOT FACE,G->ROOT GAP,RADIUS->ROOT RAD.,BL->BETA_LOW,BU->BETA_HIGH
 A1L-INC.ANGLE1_LOW,A1U-INC.ANGLE1_HIGH,A2L-INC.ANGLE2_LOW,A2U-INC.ANGLE2_HIGH
  PLEASE PRESS Print Screen KEY FOR PRINT OUT ,IN CASE YOU ARE INTERESTED

Press any key to continue...
```

Fig. 4.3d: Fourth WELDER output for example 3.

```
                    JOINT PREPERATION FOR THE FILLET WELD
                    *************************************
 OW          IW          G_LOWER    G_UPPER    OL_LOWER   OL_UPPER   AIL AIU BETA
-------------------------------------------------------------------------------
REQUIRE NO JOINT PREPERATION
-------------------------------------------------------------------------------
 0.00000 |999.99999|  0.00000|  0.00000|  0.00000|  0.00000|  0|  0|  0
         |         |         |         |         |         |   |   |

REMARKS:G->ROOT GAP,OW->OUTSIDE WELD SIZE,IW->INSIDE WELD SIZE,OL->OVERLAP
A1L->INCLUDED ANGLE_LOW,A1U->INCLUDED ANGLE_HIGH,BETA->OUTSIDE ANGLE
  PLEASE PRESS Print Screen KEY FOR PRINT OUT ,IN CASE YOU ARE INTERESTED

Press any key to continue...
```

Fig. 4.3e: Fifth WELDER output for example 3.

```
SELECTION OF CONSUMABLES & NONCONSUMABLES IN NEXT MODULE

Press any key to continue...
```

Fig. 4.3f & g: Sixth & Seventh WELDER output for example 3.

```
                PARAMETRIC VALUES FOR GROOVE TYPE WELD
                **-----------------------------------**
    OPTIMAL PROCESS : EBW



    EXACT WORKING DATA ARE NOT AVAILABLE

    COMBINATION OF PARAMETERS MAY BE SUMMARIZED AS:-
         HIGH BEAM POWER COUPLED WITH HIGH WELDING  SPEED  OF EXISTING SYSTEM
 ( APPROXIMATELY 5 OR 6 KW OF POWER WITH 120 INCH / MIN  )



  PRESS Print Screen KEY TO TAKE PRINT OUT , IN CASE YOU ARE INTERESTED

Press any key to continue...
```

Fig. 4.3h: Eight WELDER output for example 3.

```
                PARAMETRIC VALUES FOR FILLET TYPE WELD
                **-----------------------------------**
    OPTIMAL PROCESS : DFW
```

FILLER MATERIAL	TE_L	TE_U	PR_L	PR_U	TIME_L	TIME_U	WORKING ATMOSPHERE
NONE	2800	2800	0.300	0.500	10.00	10.00	ARGON
Ni+Pd	1800	1800	10.000	10.000	90.00	90.00	HELIUM
Re+Ta	1850	1850	20.000	20.000	30.00	30.00	NO INFORMATION
Cb	1700	1700	10.000	10.000	20.00	20.00	VACUUM

```
 REMARKS: TE_L->LOWER TEMPERATURE, TE_U->UPPER TEMPERATURE
 -TEMPERATURE IN FARENHIET, PR_L->LOWER PRESSURE, PR_U->UPPER PRESSURE
 -PRESSURE IN KSI, TIME_L->MINIMUM WORKING TIME, TIME_U->MAXIMUM WORKING TIME
 -TIME IN MINUTES
  PRESS Print Screen KEY TO TAKE PRINT OUT , IN CASE YOU ARE INTERESTED

Press any key to continue...
```

Fig. 4.3i: Ninth WELDER output for example 3.

Example 4 :

Input for WELDER :

Input type	Option selected	Code
Ist material name	Ceramics	108
IInd material name	Ceramics	108
Ist job shape	Large pipe	2
Unit for dimensions	inch	1
Outer diameter of the pipe (d_1)	2.0 inch	
Thickness of the pipe (t_1)	0.5 inch	
IInd job shape	Large pipe	2
Outer diameter of the pipe (d_2)	2.5 inch	
Thickness of the pipe (t_2)	0.75 inch	
Orientation of the jobs	Tee joint	3
Welding position	Not specific	5
Welding environment	Outdoor	
Welded job application	Fatigue loading	

Output from WELDER :

The output obtained from the WELDER are shown in Figure 4.4a, 4.4b, 4.4c, 4.4d and 4.4e.

TYPE OF POSSIBLE JOINT FOR THE WELDING

GROOVE TYPE

Press any key to continue...

Fig. 4.4a: First WELDER output for example 4.

NO PROCESS AVAILABLE FROM CONSIDERED PROCESSES

Press any key to continue ...

Fig. 4.4b: Second WELDER output for example 4.

Example 5 :

Input for WELDER :

Input type	Option selected	Code
Ist material name	Molybdenum	91
IInd material name	Molybdenum	91
Ist job shape	Sheet	1
Unit for dimensions	mm	3
Thickness of the sheet (t_1)	20.0 mm	
IInd job shape	Bar	4
Diameter of the bar (d_1)	15.0 mm	
Orientation of the jobs	Longitudinal lap joint	2
Welding position	Horizontal	2
Welding environment	Indoor	
Welded job application	Steady loading	

Output from WELDER :

The output obtained from the WELDER are shown in Figure 4.5a, 4.5b, 4.5c, 4.5d and 4.5e.

Discussion:

In this example, an optimal process has been selected on the basis of 'Distortion' working criteria. The fillet type of joint has been suggested with no specific preparation. In PARAM, selection of consumables has been done alongwith the welding parameters.

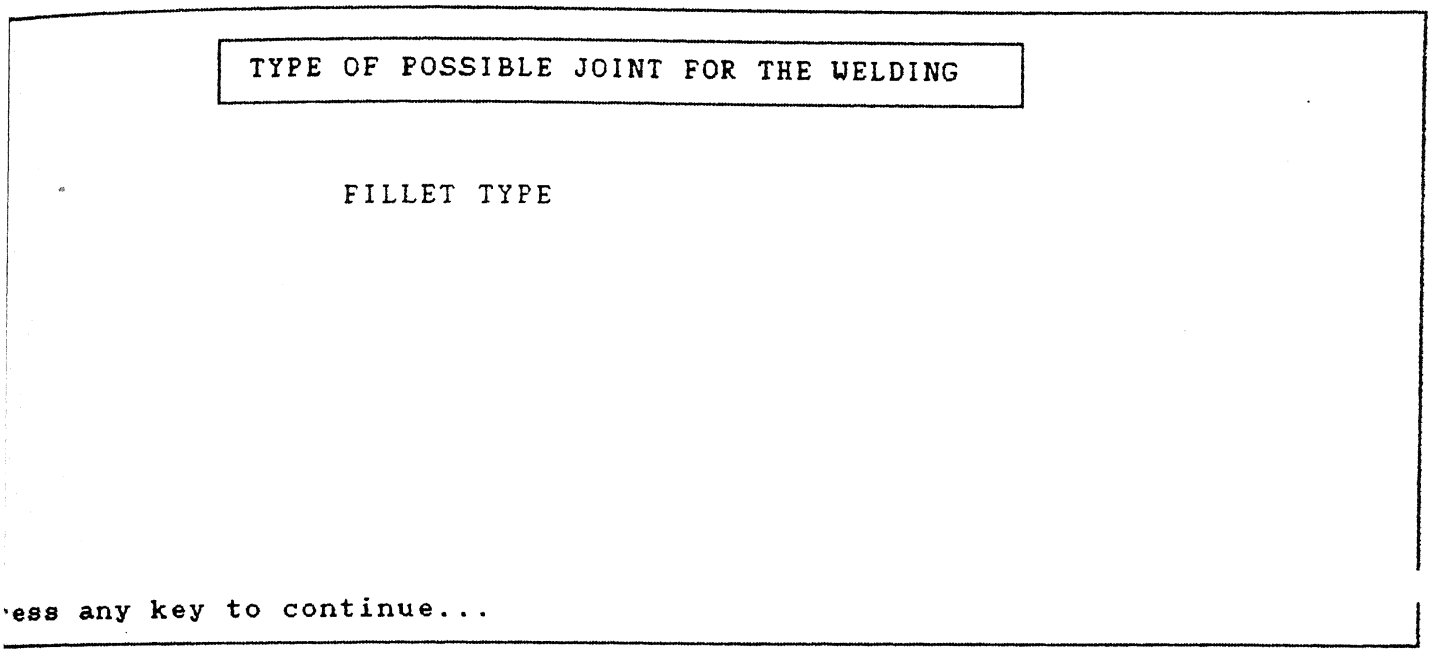


Fig. 4.5a: First WELDER output for example 5.

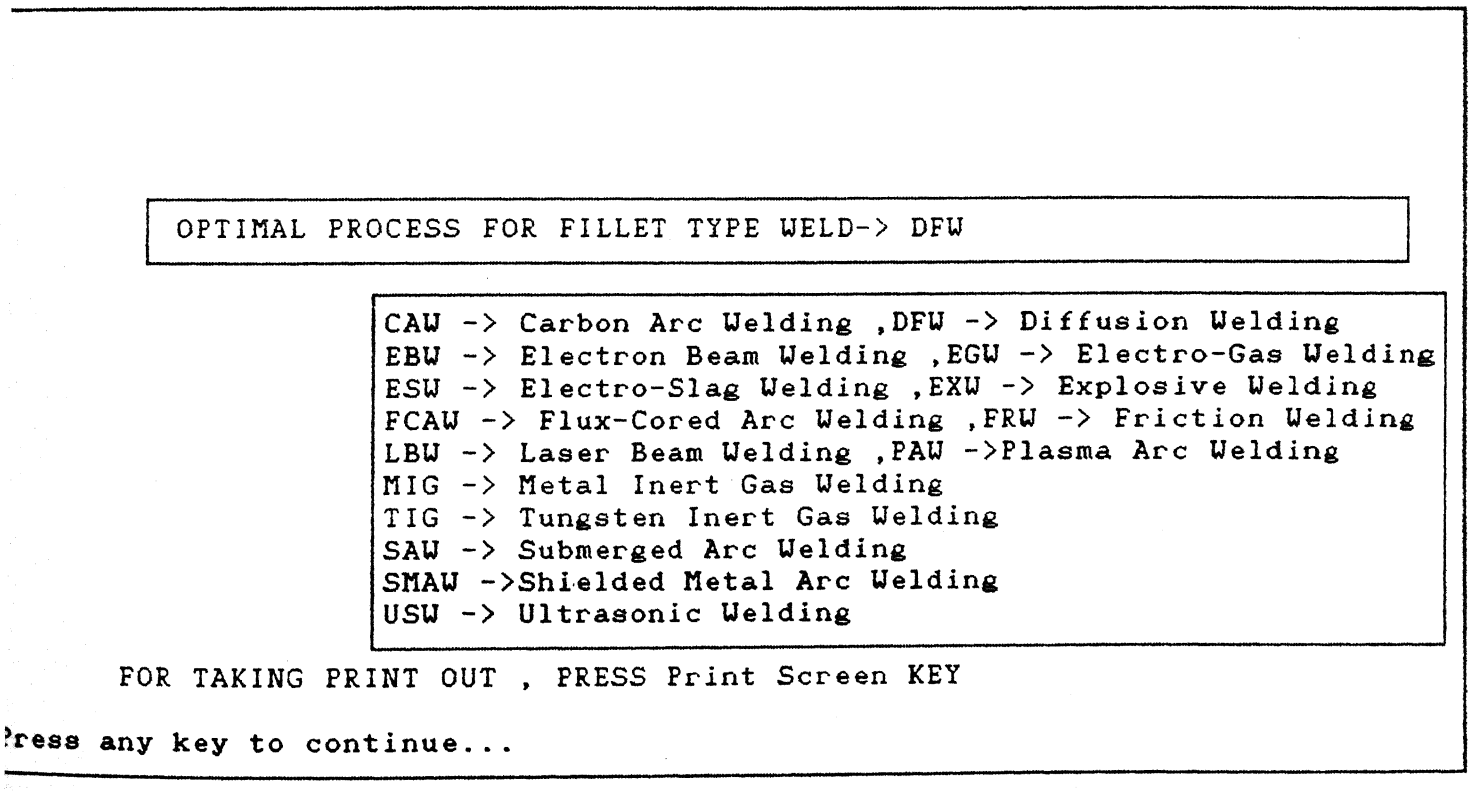


Fig. 4.5b: Second WELDER output for example 5.

JOINT PREPERATION FOR THE FILLET WELD

OW	IW	G_LOWER	G_UPPER	OL_LOWER	OL_UPPER	AIL	AIU	BETA
REQUIRE NO JOINT PREPERATION								
0.00000	999.99999	0.00000	0.00000	0.00000	0.00000	0	0	0

REMARKS:G->ROOT GAP,OW->OUTSIDE WELD SIZE,IW->INSIDE WELD SIZE,OL->OVERLAP
A1L->INCLUDED ANGLE_LOW,A1U->INCLUDED ANGLE_HIGH,BETA->OUTSIDE ANGLE
PLEASE PRESS Print Screen KEY FOR PRINT OUT ,IN CASE YOU ARE INTERESTED

Press any key to continue...

Fig. 4.5c: Third WELDER output for example 5.

SELECTION OF CONSUMABLES & NONCONSUMABLES IN NEXT MODULE

Press any key to continue...

Fig. 4.5d: Fourth WELDER output for example 5.

PARAMETRIC VALUES FOR FILLET TYPE WELD

OPTIMAL PROCESS : DFW

FILLER MATERIAL	TE_L	TE_U	PR_L	PR_U	TIME_L	TIME_U	WORKING ATMOSPHERE
NONE	2300	2600	10.000	10.000	180.00	180.00	INERT
NONE	2910	2910	1.400	1.400	20.00	20.00	VACUUM
Ti FOIL	1700	1700	10.000	10.000	120.00	120.00	ARGON
Ti FOIL	1600	1600	12.500	12.500	10.00	10.00	VACUUM

REMARKS: TE_L->LOWER TEMPERATURE, TE_U->UPPER TEMPERATURE
-TEMPERATURE IN FARENHIET, PR_L->LOWER PRESSURE, PR_U->UPPER PRESSURE
-PRESSURE IN KSI, TIME_L->MINIMUM WORKING TIME, TIME_U->MAXIMUM WORKING TIME
-TIME IN MINUTES
PRESS Print Screen KEY TO TAKE PRINT OUT , IN CASE YOU ARE INTERESTED

Press any key to continue...

Fig. 4.5e: Fifth WELDER output for example 5.

Example 6 :

Input for WELDER :

Input type	Option selected	Code
Ist material name	Stainless steel (Austenitic)-303	23
IInd material name	Stainless steel (Austenitic)-303	23
Ist job shape	Tube	3
Unit for dimensions	inch	1
Outer diameter of the pipe (d_1)	1.0 inch	
Thickness of the pipe (t_1)	0.0625 inch	
IInd job shape	Tube	3
Outer diameter of the pipe (d_2)	1.5 inch	
Thickness of the pipe (t_2)	0.125 inch	
Orientation of the jobs	Tee joint	3
Welding position	Flat	1
Welding environment	Outdoor	
Welded job application	Steady loading	

Output from WELDER :

The output obtained from the WELDER are shown in Figure 4.6a, 4.6b, 4.6c, 4.6d and 4.6e.

Discussion:

An optimal process has been selected by WELDER considering only first five governing factors (as discussed in section 3.4). Based on combination of shapes with an orientation, only groove type joint has been suggested.

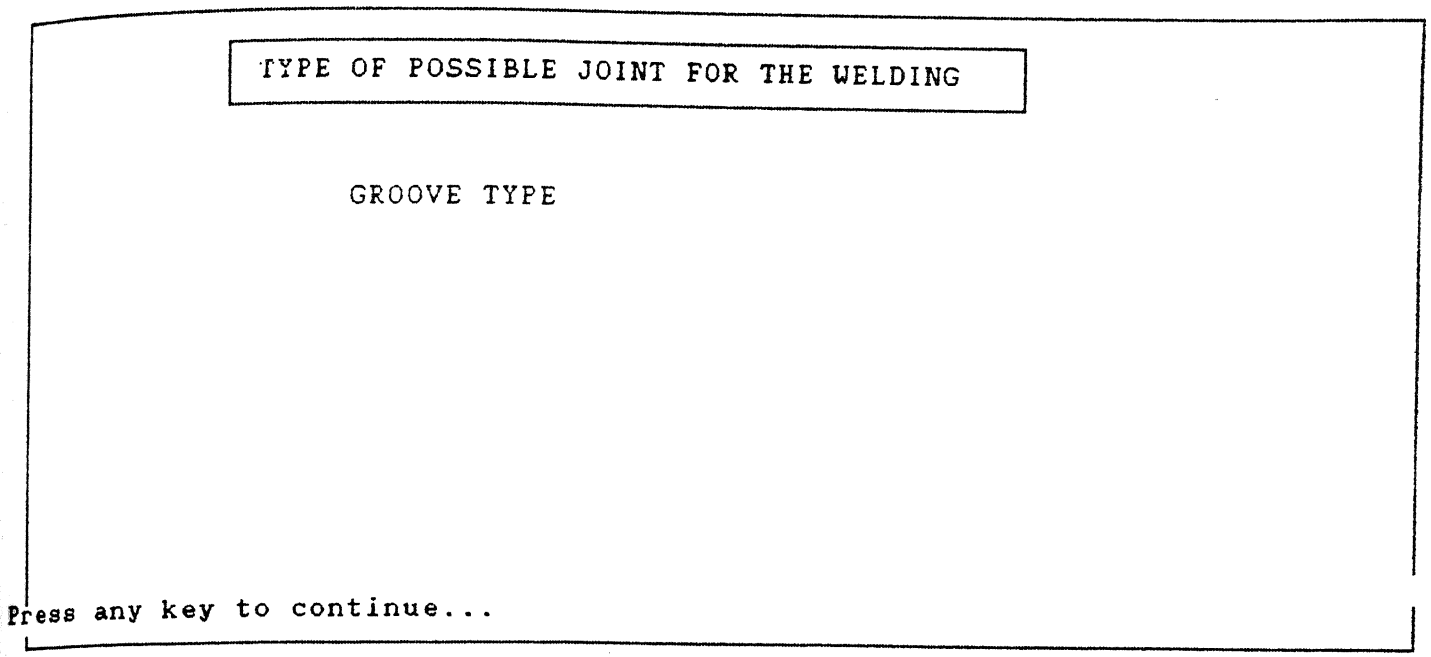


Fig. 4.6a: First WELDER output for example 6.

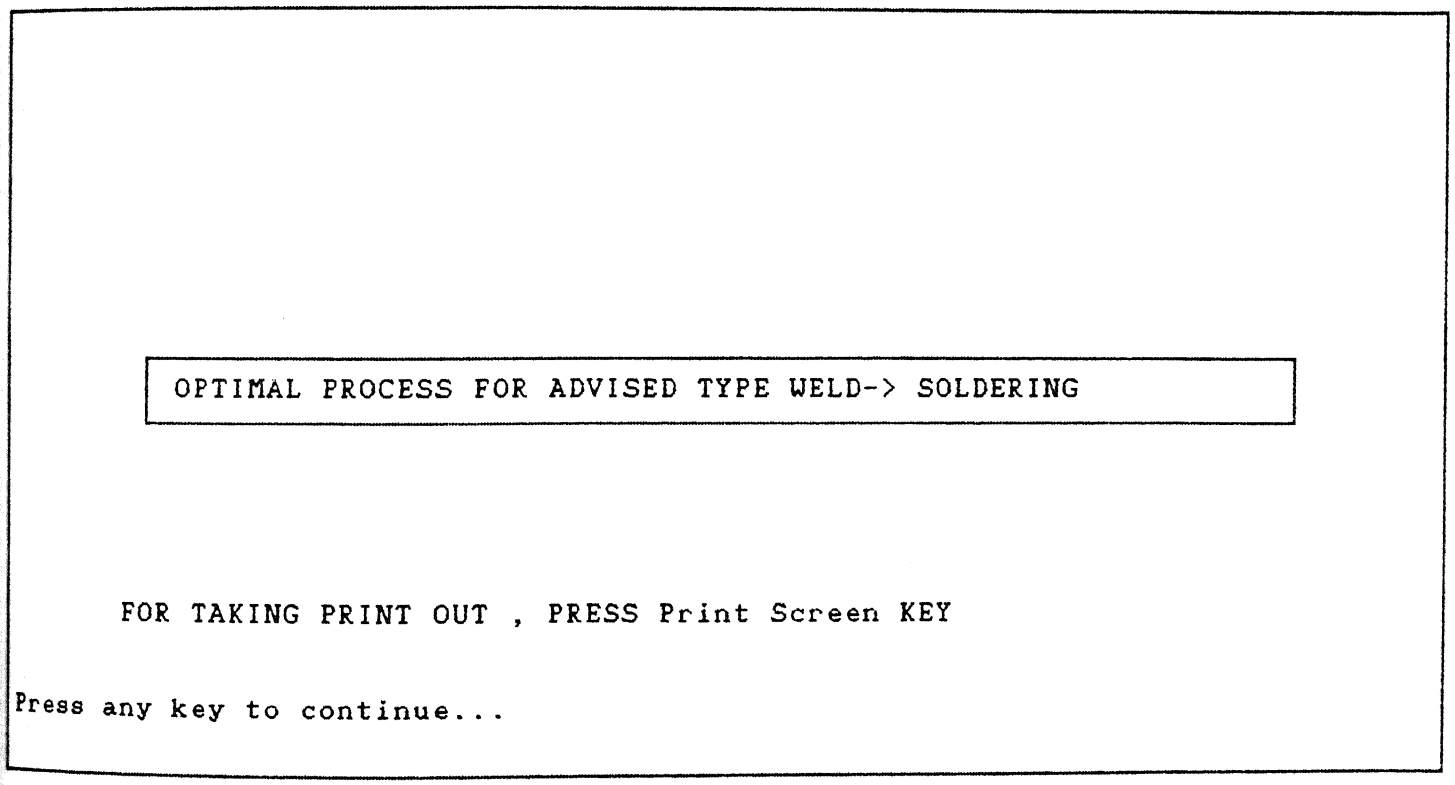


Fig. 4.6b: Second WELDER output for example 6.

```
                    JOINT PREPERATION FOR THE GROOVE WELD
 F_LOWER   F_UPPER   G_LOWER   G_UPPER   RADIUS    A1L A1U A2L  A2U  BL   BU
SINGLE GROOVE WELDING FROM ONE SIDE WITHOUT BACKING STRIP
 SQUARE GROOVE (RARELY USED)
 0.00000 | 0.00000| 0.00000| 0.00000| 0.00000|  0   0   0|  0   0   0
SINGLE GROOVE WELDING FROM BOTH SIDE
 SQUARE GROOVE (RARELY USED)
 0.00000 | 0.00000| 0.00000| 0.00000| 0.00000|  0   0   0|  0   0   0

 REMARK:F->ROOT FACE,G->ROOT GAP,RADIUS->ROOT RAD.,BL->BETA_LOW,BU->BETA_HIGH
 A1L-INC.ANGLE1_LOW,A1U-INC.ANGLE1_HIGH,A2L-INC.ANGLE2_LOW,A2U-INC.ANGLE2_HIGH
  PLEASE PRESS Print Screen KEY FOR PRINT OUT ,IN CASE YOU ARE INTERESTED

Press any key to continue...
```

Fig. 4.6c: Third WELDER output for example 6.

```
   SELECTION OF CONSUMABLES & NONCONSUMABLES IN NEXT MODULE

Press any key to continue...
```

Fig. 4.6d: Fourth WELDER output for example 6.

PARAMETRIC VALUES FOR GROOVE TYPE WELD

OPTIMAL PROCESS : SOLDERING

SOLDERABILITY	PREPLATING	SOLDER USED	SOLT_L	SOLT_U
VERY DIFFICULT TO SOLDER	NO	ASTM 50 - Sn+Pb	421	421

TYPE OF FLUXES USED

**INORGANIC FLUXES*
1. ZINC CHLORIDE
2. AMMONIUM CHLORIDE
3. SODIUM CHLORIDE , etc.

REMARKS:SOLT_L->LOW SOLDERING TEMP.,SOLT_U->HIGH SOLDERING TEMP.,in FAREN.
PRESS Print Screen KEY TO TAKE PRINT OUT , IN CASE YOU ARE INTERESTED

Press any key to continue...

Fig. 4.6e: Fifth WELDER output for example 6.

Example 7 :

Input for WELDER :

Input type	Option selected	Code
Ist material name	Aluminium cast alloy - 333	41
IInd material name	Titanium	101
Ist job shape	Tube	3
Unit for dimensions	inch	1
Outer diameter of tube (d_1)	6.0 inch	
Thickness of the tube (t_1)	1.0 inch	
IInd job shape	Sheet	1
Thickness of the sheet (t_2)	1.5 inch	
Orientation of the jobs	Corner joint	4
Welding position	Vertical	3
Welding environment	Indoor	
Welded job application	Steady loading	

Output from WELDER :

The output obtained from the WELDER are shown in Figure 4.7a, 4.7b, 4.7c, 4.7d, 4.7e, 4.7f, 4.7g, 4.7h and 4.7i.

Discussion:

For entered combination of dissimilar materials, both type of joints have been suggested along with the same optimal process on the basis of 'Weld strength' working criteria. In PARAM, same consumables and welding parameters have been selected as the process is same for both type of joints.

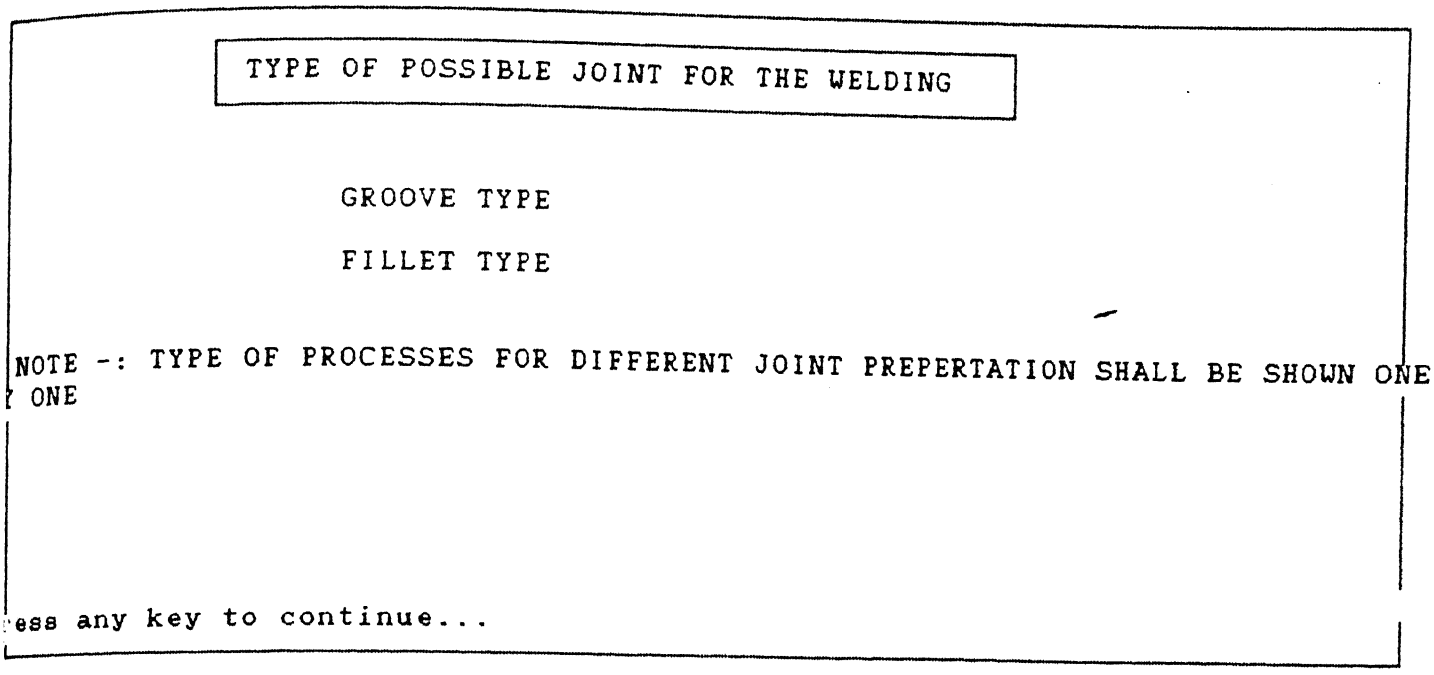


Fig. 4.7a: First WELDER output for example 7.

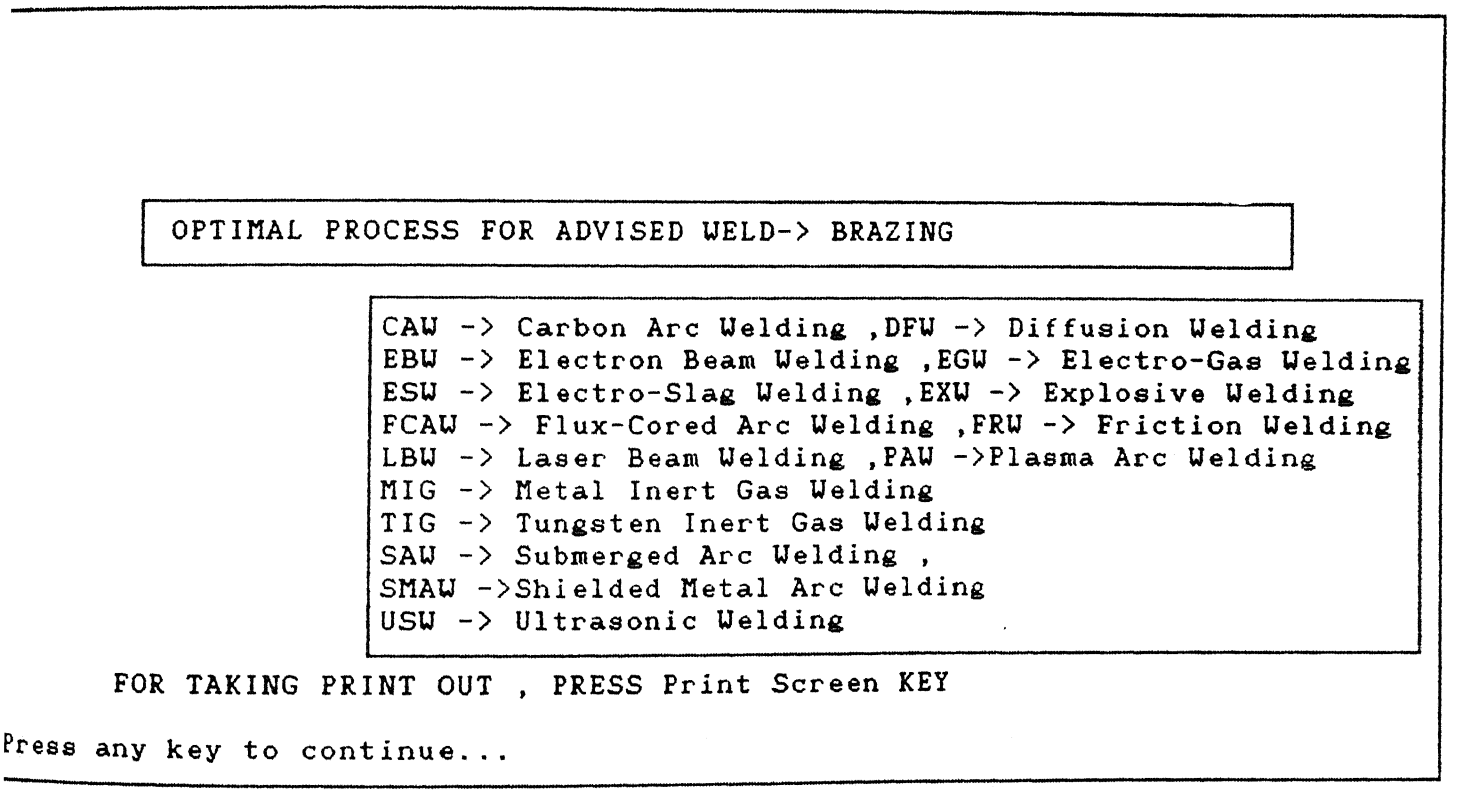


Fig. 4.7b: Second WELDER output for example 7.

```
OPTIMAL PROCESS FOR FILLET TYPE WELD-> BRAZING

CAW -> Carbon Arc Welding ,DFW -> Diffusion Welding
EBW -> Electron Beam Welding ,EGW -> Electro-Gas Welding
ESW -> Electro-Slag Welding ,EXW -> Explosive Welding
FCAW -> Flux-Cored Arc Welding ,FRW -> Friction Welding
LBW -> Laser Beam Welding ,PAW ->Plasma Arc Welding
MIG -> Metal Inert Gas Welding
TIG -> Tungsten Inert Gas Welding
SAW -> Submerged Arc Welding
SMAW ->Shielded Metal Arc Welding
USW -> Ultrasonic Welding

FOR TAKING PRINT OUT , PRESS Print Screen KEY

Press any key to continue...
```

Fig. 4.7c: Third WELDER output for example 7.

```
                    JOINT PREPERATION FOR THE GROOVE WELD
 F_LOWER    F_UPPER    G_LOWER    G_UPPER    RADIUS     A1L A1U A2L  A2U  BL   BU
-------------------------------------------------------------------------------
SINGLE GROOVE WELDING FROM ONE SIDE WITHOUT BACKING STRIP
 SQUARE GROOVE (RARELY USED)
  0.00000 |  0.00000|  0.00000|  0.00000|  0.00000|   0   0   0|  0   0   0
SINGLE GROOVE WELDING FROM BOTH SIDE
 SQUARE GROOVE (RARELY USED)
  0.00000 |  0.00000|  0.00000|  0.00000|  0.00000|   0   0   0|  0   0   0
          |         |         |         |         |

 REMARK:F->ROOT FACE,G->ROOT GAP,RADIUS->ROOT RAD.,BL->BETA_LOW,BU->BETA_HIGH
 A1L-INC.ANGLE1_LOW,A1U-INC.ANGLE1_HIGH,A2L-INC.ANGLE2_LOW,A2U-INC.ANGLE2_HIGH
  PLEASE PRESS Print Screen KEY FOR PRINT OUT ,IN CASE YOU ARE INTERESTED

Press any key to continue...
```

Fig. 4.7d: Fourth WELDER output for example 7.

```
                    JOINT PREPERATION FOR THE FILLET WELD
                    *************************************
 OW          IW          G_LOWER    G_UPPER    OL_LOWER   OL_UPPER   AIL AIU BETA
-------------------------------------------------------------------------------
PRELAPPED FILLET JOINT ( OVERLAP >= 3 TIMES THE WORKING THICKNESS (WT) )
-------------------------------------------------------------------------------
  0.75000 |999.99999|  0.00000|  0.00000|  0.00000|  0.00000|  0|  0|  0
          |         |         |         |         |         |   |   |

-------------------------------------------------------------------------------
REMARKS:G->ROOT GAP,OW->OUTSIDE WELD SIZE,IW->INSIDE WELD SIZE,OL->OVERLAP
A1L->INCLUDED ANGLE_LOW,A1U->INCLUDED ANGLE_HIGH,BETA->OUTSIDE ANGLE
  PLEASE PRESS Print Screen KEY FOR PRINT OUT ,IN CASE YOU ARE INTERESTED

Press any key to continue...
```

Fig. 4.7e: Fifth WELDER output for example 7.

```
ELECTRODE SELECTION FOR DISSIMILAR MATERIAL IN NEXT PHASE
WITH SELECTION OF PARAMETERIC VALUES


  PRESS Print Screen KEY TO TAKE PRINT OUT, IN CASE YOU ARE INTERESTED

Press any key to continue...
```

Fig. 4.7f&g: Six & Seventh WELDER output for example 7.

PARAMETRIC VALUES FOR GROOVE TYPE WELD

OPTIMAL PROCESS : BRAZING

FILLER MATERIAL	JC_L	JC_U	BT_L	BT_U	AWS_FLUX SPECIFICATION
BA1Si	0.006	0.024	1060	1150	FB1A , FB1B , FB1C

HEATING METHOD RECOMMENDED:NO INFORMATION

HEATING METHOD OF LIMITED USE:NO INFORMATION

REMARKS:BT_L->BRAZING TEMP.LOWER,BT_U->BRAZING TEMP.UPPER ,TEMP. in FAREN.
JC_L->JOINT CLEARANCE LOWER, JC_U->JOINT CLEARANCE UPPER
PRESS Print Screen KEY TO TAKE PRINT OUT , IN CASE YOU ARE INTERESTED

Press any key to continue...

Fig. 4.7h: Eight WELDER output for example 7.

PARAMETRIC VALUES FOR FILLET TYPE WELD

OPTIMAL PROCESS : BRAZING

FILLER MATERIAL	JC_L	JC_U	BT_L	BT_U	AWS_FLUX SPECIFICATION
BA1Si	0.006	0.024	1060	1150	FB1A , FB1B , FB1C

HEATING METHOD RECOMMENDED:NO INFORMATION

HEATING METHOD OF LIMITED USE:NO INFORMATION

REMARKS:BT_L->BRAZING TEMP.LOWER,BT_U->BRAZING TEMP.UPPER ,TEMP. in FAREN.
JC_L->JOINT CLEARANCE LOWER, JC_U->JOINT CLEARANCE UPPER
PRESS Print Screen KEY TO TAKE PRINT OUT , IN CASE YOU ARE INTERESTED

Press any key to continue...

Fig. 4.7i: Ninth WELDER output for example 7.

Example 8 :

Input for WELDER :

Input type	Option selected	Code
Ist material name	Bronze	83
IInd material name	Low carbon steel	1
Ist job shape	Bar	4
Unit for dimensions	inch	1
Diameter of bar (d_1)	1.5 inch	
IInd job shape	Bar	4
Diameter of bar (d_2)	2.5 inch	
Orientation of the jobs	Longitudinal butt joint	1
Welding position	Not specific	5
Welding environment	Indoor	
Welded job application	Fatigue loading	

Output from WELDER :

The output obtained from the WELDER are shown in Figure 4.8a, 4.8b, 4.8c, 4.8d and 4.8e.

Discussion:

An optimal process has been selected on the basis 'Welding speed' working criteria along-with groove type of joint only with no specific preparation.

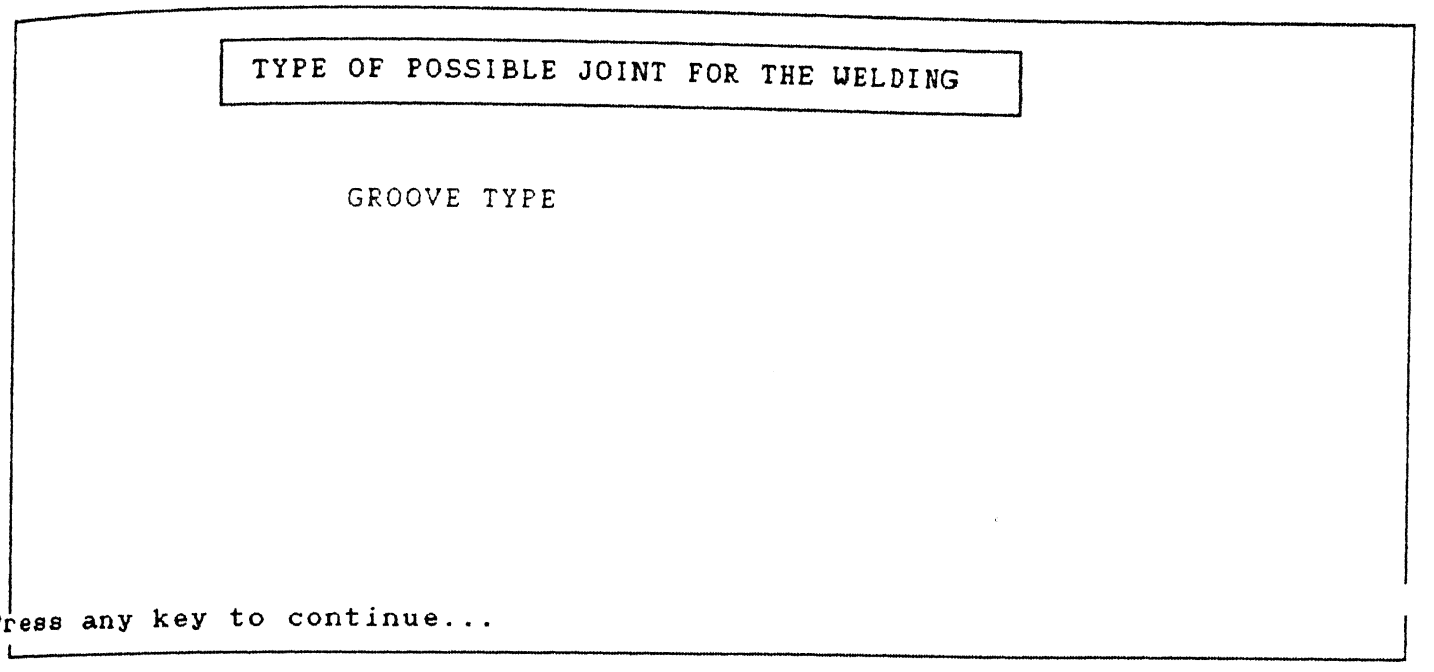


Fig. 4.8a: First WELDER output for example 8.

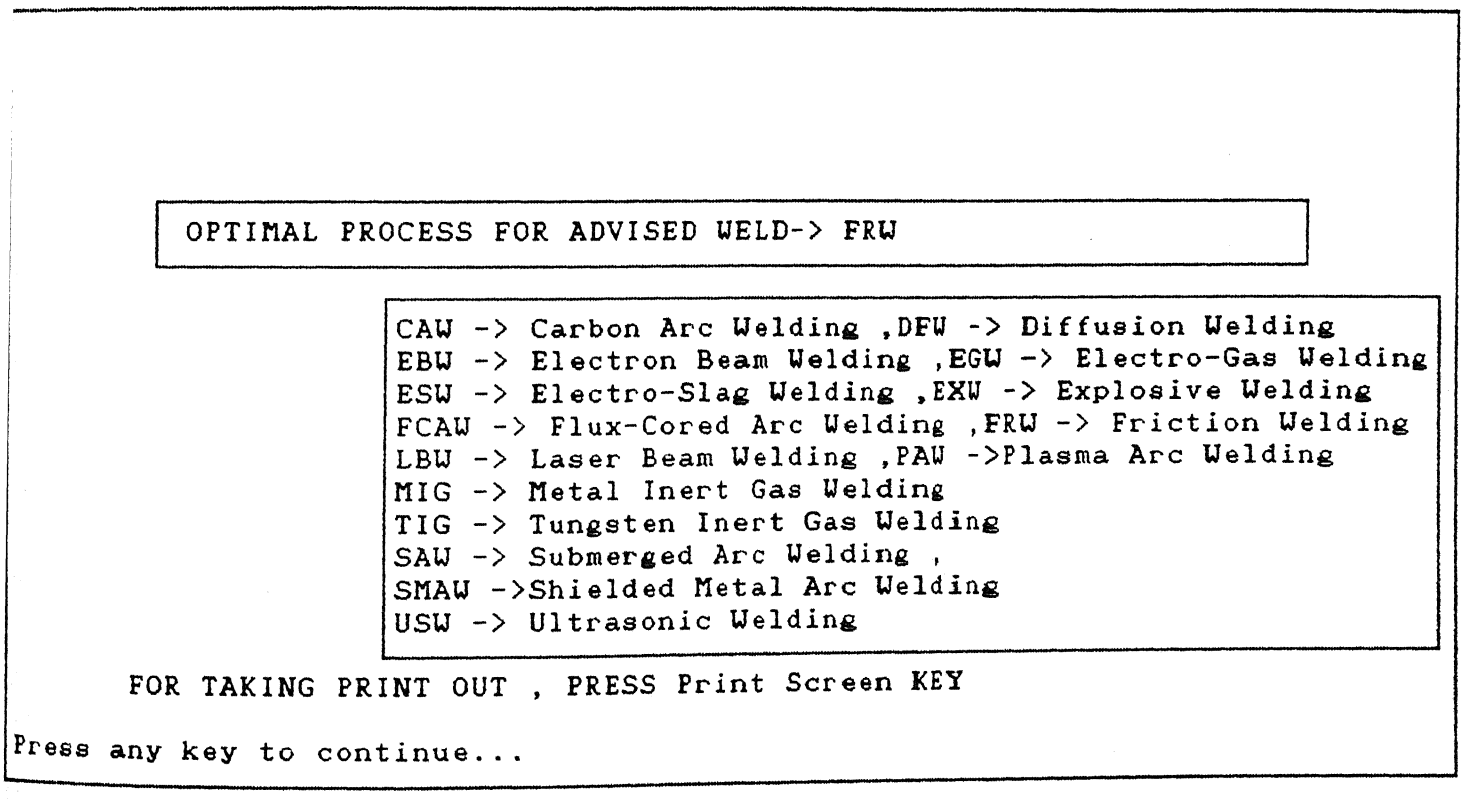


Fig. 4.8b: Second WELDER output for example 8.

```
                    JOINT PREPERATION FOR THE GROOVE WELD
 F_LOWER    F_UPPER    G_LOWER    G_UPPER    RADIUS     A1L A1U A2L  A2U  BL    BU

NOT SPECIFIED
 PREPERATION FOR SQUARENESS WITHIN 0.01 inch / inch OF JOINT DIAMETER
  0.00000 |  0.00000|  0.00000|  0.00000|  0.00000|    0   0   0|  0   0    0
          |         |         |         |         |    |   |    |      |    |

 REMARK:F->ROOT FACE,G->ROOT GAP,RADIUS->ROOT RAD.,BL->BETA_LOW,BU->BETA_HIGH
 A1L-INC.ANGLE1_LOW,A1U-INC.ANGLE1_HIGH,A2L-INC.ANGLE2_LOW,A2U-INC.ANGLE2_HIGH
  PLEASE PRESS Print Screen KEY FOR PRINT OUT ,IN CASE YOU ARE INTERESTED

Press any key to continue...
```

Fig. 4.8c: Third WELDER output for example 8.

```
ELECTRODE SELECTION FOR DISSIMILAR MATERIAL IN NEXT PHASE
WITH SELECTION OF PARAMETERIC VALUES


 PRESS Print Screen KEY TO TAKE PRINT OUT, IN CASE YOU ARE INTERESTED

Press any key to continue...
```

Fig. 4.8d: Fourth WELDER output for example 8.

```
            PARAMETRIC VALUES FOR GROOVE TYPE WELD
            **-------------------------------------**
OPTIMAL PROCESS : FRW

NO DATA AVAILABLE FOR ENTERED COMBINATION OF MATERIALS

PRESS Print Screen KEY TO TAKE PRINT OUT , IN CASE YOU ARE INTERESTED
Press any key to continue...
```

Fig. 4.8e: Fifth WELDER output for example 8.

Example 9 :

Input for WELDER :

Input type	Option selected	Code
Ist material name	Ceramics	108
IInd material name	Zirconium	103
Ist job shape	Sheet	1
Unit for dimensions	inch	1
Thickness of the sheet (t_1)	2.0 inch	
IInd job shape	Large pipe	2
Outer diameter of the pipe (d_2)	4.0 inch	
Thickness of the (t_2)	0.125 inch	
Orientation of the jobs	Attachment	6
Part to be attached	Sheet	1
Welding position	Horizontal	2
Welding environment	Indoor	
Welded job application	Steady loading	

Output from WELDER :

The output obtained from the WELDER are shown in Figure 4.9a, 4.9b, 4.9c, 4.9d and 4.9e.

Discussion:

In this example, fillet type of joint has been suggested for an optimal welding process, selected considering first five governing factors (as discussed in section 3.4). Due to non-availability of data in subsystem PARAM, nothing is suggested for consumables and welding parameters.

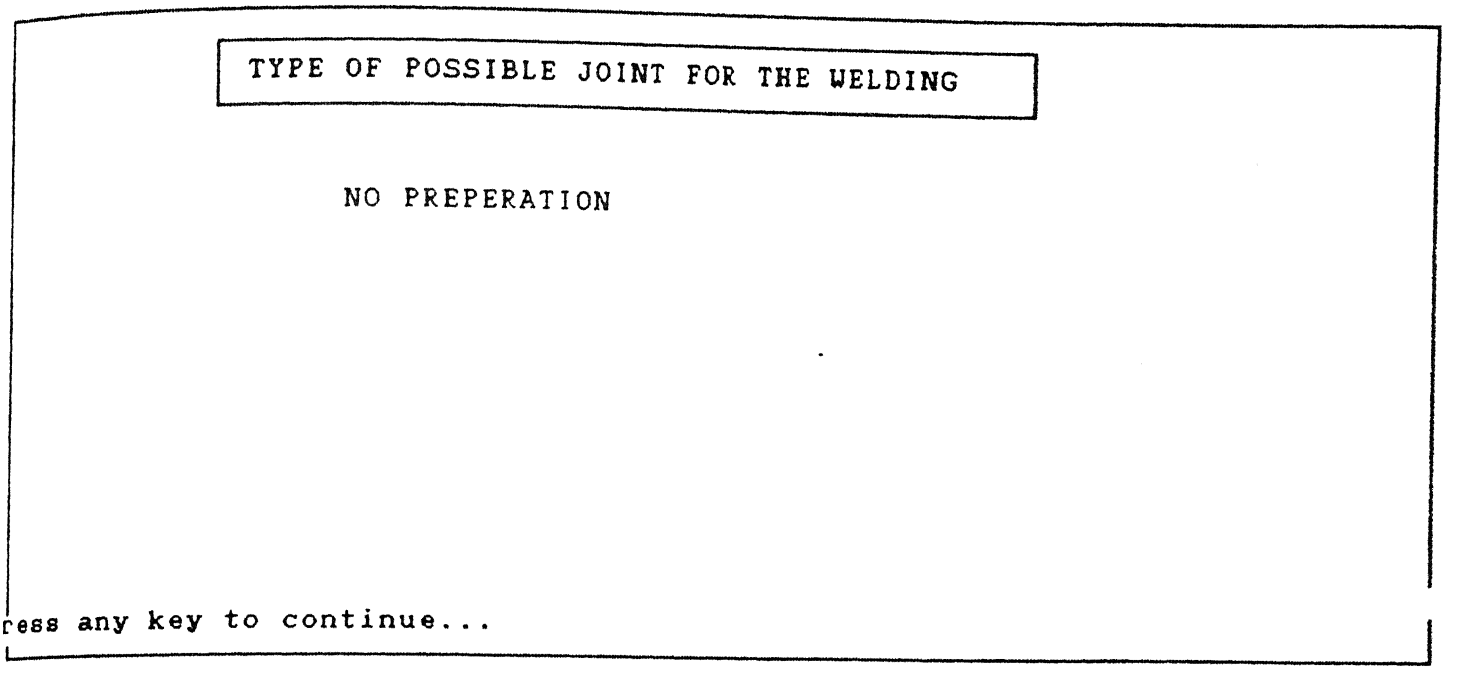


Fig. 4.9a: First WELDER output for example 9.

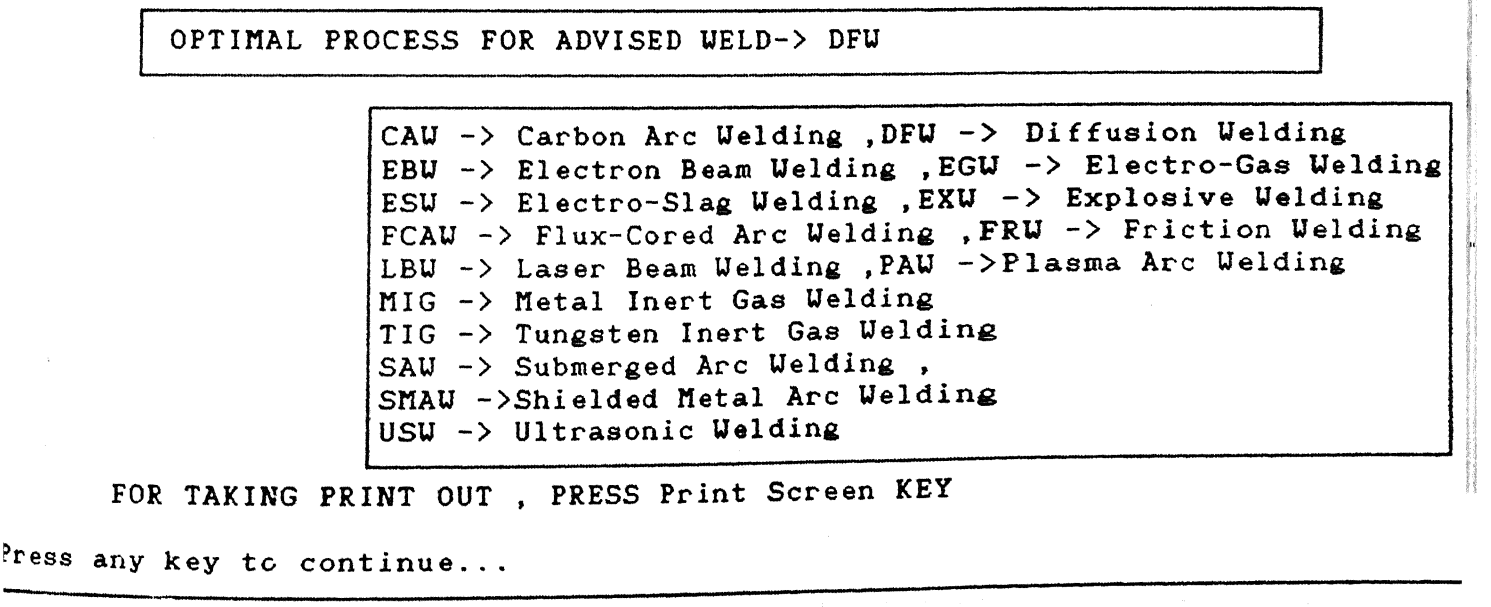


Fig. 4.9b: Second WELDER output for example 9.

NO PREPERATION IS NEEDED FOR THIS TYPE OF JOINT

Press any key to continue...

Fig. 4.9c: Third WELDER output for example 9 .

ELECTRODE SELECTION FOR DISSIMILAR MATERIAL IN NEXT PHASE
WITH SELECTION OF PARAMETERIC VALUES

PRESS Print Screen KEY TO TAKE PRINT OUT, IN CASE YOU ARE INTERESTED

Press any key to continue...

Fig. 4.9d: Fourth WELDER output for example 9.

```
            PARAMETRIC VALUES FOR ATTACHMENT WELD
            **---------------------------------**
 OPTIMAL PROCESS : DFW

 NO DATA AVAILABLE FOR THIS COMBINATION OF MATERIALS

PRESS Print Screen KEY TO TAKE PRINT OUT , IN CASE YOU ARE INTERESTED
ss any key to continue...
```

Fig. 4.9e: Fifth WELDER output for example 9.

Chapter 5

CONCLUSIONS

5.1 Conclusions and Limitation

The literature survey of expert system developed for welding industry reveals that the most of the researchers have emphasized their work for the selection of welding procedure for a particular process to be used for welding specific combination of materials. The concept on the selection of optimal welding operation considering various factors is yet to be exploited for the development of expert systems.

In the present thesis an attempt has been made to develop an expert system WELDER for the selection of optimal process alongwith the selection of welding procedure e.g. joint preparation, consumables and non-consumables, and welding parameters. This system has been developed for most of the weldable possible combination of similar or dissimilar materials.

The main function of the WELDER is to suggest the best suited process among the considered 20 type of prevalent welding processes. This module of WELDER is governed by various factors e.g. metal properties, shapes and orientation of jobs, welding position etc. . The other three modules of the WELDER suggest for appropriate joint preparation with joint geometry specifications, electrodes compatible with base-materials and welder's requirements and best suited welding parameters for suggested optimal process. The func-

tioning of all the modules of the system WELDER is fully dependent upon knowledge base structured in various database files related with welding information.

Thus, the quality of decision of this system depends upon knowledgebase gathered from various resources. Although there is enormous data involved in decision making, yet knowledge base related with selection of welding parameters for some processes e.g. EXW, LBW and DFW is not sufficient. More is the variety of data involved in decision making, more efficient and accurate is the result obtained. For some processes e.g. TIG, MIG etc., welding parameter selection is also dependent upon working thickness, material type, type of joint design and welding position. But due to non-availability of sufficient knowledgebase, welding parameter selection is assumed to be dependent at times on either of the factor alone.

The working of expert system is preferable to have minimum of interactions with the user, so that it can advise automatically with least human interventions. Under this condition, the expert system can be said to be an automatic decision making system. In WELDER, user interactions are needed at two places besides at the time of entering the inputs. One is needed at the time of entering name of optimal process from a list of suggested alternatives. Another one is needed sometimes while selecting the desired properties of welded jobs for consumables selection for some processes e.g. SMAW, FCAW etc.

5.2 Future course of work - Some suggestions

The following possibilities are realized at this stage for future expansion of the system WELDER :

- The WELDER has considered only 20 types of welding processes among numerous others. So the same system can be extended to cover all possible processes of joining.
- Inclusion of all type of alloys, variety and condition (annealed/forged/chilled etc.) of materials to the considered 123 types of materials can enhance the capability of

WELDER.

- The joint preparation and welding parameters for process are dependent upon various factors. Due to non-availability of data, joint preparations have not been taken as material dependent and also joint details have not been considered for brazing and soldering.

- Graphical interface can be done with WELDER for joint geometry and welding procedure (e.g. shapes, orientation, electrode angle etc.).

- For dissimilar combinations of materials, only solid state and solid/liquid state welding processes have been taken into account. But now, this can be welded using a few liquid state welding processes also (e.g. TIG, MIG etc.).

- For selecting the consumables AWS specifications, involved working cost factor has not been considered. This factor depends upon the joint preparation, diameter of filler material, travel speed of filler material and some other factors. The other factors as joint preparation and operating characteristics are to be considered.

- Addition of other shape types and working criteria are possible for this expert system WELDER.

- For selecting the optimal process, the WELDER has not considered the equipment and working costs, and welder's skill factor.

- Diagnosis of welding defects due to improper welding environment for a process, has not been considered.

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APPENDIX-A

USER'S MANUAL

This appendix gives the user necessary instructions to run the software package for welding processes.

The following commands are to used for running this program. It is to be noted that the user must possess floppy disk which contains the above-mentioned package. The capital lettered commands are to be entered by the user. Firstly, make a directory named 'WELDER' in any drive and copy all database and program files from floppy to the computer memory using following commands :

```
c:> MD WELDER
c:> A:
a:> COPY *.* C/WELDER
a:> C:
c:> CD WELDER
```

Now before entering following commands, make sure that Dbase-4.2 is in the path.

```
c:/welder> DBASE
```

After entering this command user will be in dot prompt of Dbase-4.2 working environment.

- DO WELDER

This command starts execution of developed system WELDER. Now user has to enter the inputs in a sequence requested by the system. After entering the inputs, WELDER starts recommending the process, joint type, joint preparation etc. and then user has to interact with the system for the selection of an optimal process, and for consumable and non-consumable selection for some processes e.g. SMAW, FCAW etc..

After the output is displayed according to the user's inputs, dot prompt appears again which shows the end of execution of WELDER. The user can quit the Dbase-4.2 working environment by

- QUIT

This takes the user back to the DOS command mode.

APPENDIX-B

STRUCTURE OF DATABASE FILES

SN.	File Name	Purpose
1.	Material.dbf	Material name, code, tensile strength
2.	Jobshape.dbf	Shape type and code
3.	Joborient.dbf	Orientation type and code
4.	Weldpos.dbf	Welding position type and code
5.	Input1.dbf	Selected options for input, as entered by user
6.	Input2.dbf	Selected inputs needed in SELECT module
7.	Smpromat.dbf	Processes for similar combination of materials based on it's type
8.	Dspromat.dbf	Processes for dissimilar combination of materials based on it's type
9.	Comshape.dbf	Procedure code based on combination of shapes with an orientation
10.	Proshap.dbf	Processes based on shapes combination with a joint type
11.	Prothick.dbf	Working thickness range for processes
12.	Proposi.dbf	Processes based on welding position
13.	Proenv.dbf	Processes based on welding environment
14.	Proapp.dbf	Processes based on welded job application
15.	Criteria.dbf	Process sequence based on various working criteria
16.	Input3.dbf	Selected entries needed in PREPARE module
17.	Grjoipre.dbf	Groove joint design and preparations
18.	Vgrang.dbf	Included angle for V groove joint
19.	Angrang.dbf	Included angle for angular orientation of groove joint
20.	Fjoipre.dbf	Fillet joint design and preparations
21.	Input4.dbf	Selected entries needed in RESOURCE module
22.	Electrod.dbf	Consumable electrode and non-consumable electrode specifications for some materials
23.	Input5.dbf	Selected entries needed in PARAM module
24.	Brazfill.dbf	Filler materials and heating methods for brazing
25.	Brazpara.dbf	Other welding parameters for brazing
26.	Soldering.dbf	Welding parameters for soldering
27.	Ebw.dbf	Welding parameters for EBW
28.	Lbw.dbf	Welding parameters for LBW
29.	Frw.dbf	Welding parameters for FRW
30.	Usw.dbf	Welding parameters for USW

continued ...

SN.	File Name	Purpose
31.	Esw.dbf	Welding parameters for ESW
32.	Caw.dbf	Welding parameters for CAW
33.	Sawpara.dbf	Welding parameters for SAW
34.	Smawweld.dbf	Welding techniques for SMAW
35.	Smawpara.dbf	Welding parameters for SMAW
36.	Egw.dbf	Welding parameters for EGW
37.	Dfw.dbf	Welding parameters for DFW
38.	Fcawftpa.dbf	Welding parameters for fillet joint for FCAW
39.	Fcawgrpa.dbf	Welding parameters for groove joint for FCAW
40.	Pawshgas.dbf	Shielding gases for PAW
41.	Pawpara.dbf	Welding parameters for PAW
42.	Migshgas.dbf	Shielding gases for MIG-SPRAY, TIG-SPRAY, MIG-PULSED
43.	Dmigshgas.dbf	Shielding gases for MIG-SHORT-DIP AND TIG-SHORT-DIP
44.	Migpara.dbf	Welding parameters for MIG
45.	Otmigpara.dbf	Welding parameters for MIG
46.	Ottigpara.dbf	Welding parameters for TIG
47.	Tigpara.dbf	Welding parameters for TIG

MATERIAL.DBF (Material name.code & tensile strength)

Structure for database: D:\USER\NEELESH\MATERIAL.DBF
Number of data records: 123
Date of last update : 05/02/94

Field	Field Name	Type	Width	Dec	Index
1	MATL_NAME	Character	40		N
2	NOTATION	Character	8		N
3	NUMBER	Numeric	3		N
4	TENS_KSI	Numeric	5		N
** Total **			57		

JOBSHAPE.DBF (Shape type & code)

Structure for database: D:\USER\NEELESH\JOBSHAPE.DBF
Number of data records: 4
Date of last update : 05/02/94

Field	Field Name	Type	Width	Dec	Index
1	SHAP_TYPE	Character	25		N
2	SHAP_CODE	Numeric	1		N
** Total **			27		

JOBORIENT.DBF (Orientation type & code)

Structure for database: D:\USER\NEELESH\JOBORIEN.DBF
Number of data records: 6
Date of last update : 03/11/94

Field	Field Name	Type	Width	Dec	Index
1	ORIEN	Character	30		N
2	ORIEN_CODE	Numeric	1		N
** Total **			32		

WELDPOS.DBF (Welding position & code)

Structure for database: D:\USER\NEELESH\WELDPOS.DBF
Number of data records: 5
Date of last update : 03/11/94

Field	Field Name	Type	Width	Dec	Index
1	WELD_POSI	Character	20		N
2	POSI_CODE	Numeric	1		N
** Total **			22		

INPUT1

Structure for database: D:\USER\NEELESH\INPUT1.DBF
Number of data records: 1
Date of last update : 05/02/94

Field	Field Name	Type	Width	Dec	Index
1	MATERIAL1	Character	40		N
2	MATERIAL2	Character	40		N
3	SHAPE1	Character	25		N
4	SHAPE2	Character	25		N
5	UNIT	Character	4		N
6	THICKNESS1	Numeric	9	5	N
7	DIAMETER1	Numeric	9	5	N
8	THICKNESS2	Numeric	9	5	N
9	DIAMETER2	Numeric	9	5	N
10	ORIENTATIO	Character	30		N
11	INCL_ANGLE	Numeric	6	2	N
12	WELDG_POSI	Character	20		N
13	ATTACH_AT	Numeric	9	5	N
14	ATTACH_AD	Numeric	9	5	N
15	OUT_WELDG	Character	1		N
16	FAT_LOADG	Character	1		N
** Total **			247		

INPUT2

Structure for database: D:\USER\NEELESH\INPUT2.DBF
Number of data records: 0
Date of last update : 05/03/94

Field	Field Name	Type	Width	Dec	Index
1	MATERIAL1	Character	40		N
2	NUMBER1	Numeric	3		N
3	NOTATION1	Character	8		N
4	MATERIAL2	Character	40		N
5	NUMBER2	Numeric	3		N
6	NOTATION2	Character	8		N
7	SHAPE1	Character	25		N
8	SHAP_CODE1	Numeric	1		N
9	UNIT	Character	4		N
10	THICKNESS1	Numeric	9	5	N
11	DIAMETER1	Numeric	9	5	N
12	SHAPE2	Character	25		N
13	SHAP_CODE2	Numeric	1		N
14	THICKNESS2	Numeric	9	5	N
15	DIAMETER2	Numeric	9	5	N
16	ORIENTATIO	Character	30		N
17	ORIEN_CODE	Numeric	1		N

Press any key to continue...

18	WELDG_POSI	Character	20		N
19	WPOSI_CODE	Numeric	1		N
20	OUT_WELDG	Character	1		N
21	FAT_LOADG	Character	1		N
** Total **			249		

SMPROMAT.DBF (Processes for similar combination of materials based on it's type)

Structure for database: D:\USER\NEELESH\SMPROMAT.DBF
Number of data records: 124
Date of last update : 03/15/94

Field	Field Name	Type	Width	Dec	Index
1	MATL_NAME	Character	37		N
2	CAW	Character	1		N
3	EGW	Character	1		N
4	ESW	Character	1		N
5	FCAW	Character	1		N
6	MIG	Character	1		N
7	PAW	Character	1		N
8	SAW	Character	1		N
9	SMAW	Character	1		N
10	TIG	Character	1		N
11	BRAZING	Character	1		N
12	DFW	Character	1		N
13	EBW	Character	1		N
14	EXW	Character	1		N
15	FRW	Character	1		N
16	LBW	Character	1		N
17	SOLDERING	Character	1		N

Press any key to continue...

18	USW	Character	1		N
** Total **			55		

DSPROMAT.DBF (Processes for dissimilar combination of materials based on it's type)

Structure for database: D:\USER\NEELESH\DSPROMAT.DBF
Number of data records: 1425
Date of last update : 03/15/94

Field	Field Name	Type	Width	Dec	Index
1	NOTATION1	Character	8		N
2	NOTATION2	Character	8		N
3	PROCESS	Character	8		N
** Total **			25		

COMSHAPE.DBF (Procedure code based on combination of shapes with an orientation)

Structure for database: D:\USER\NEELESH\COMSHAPE.DBF
Number of data records: 60
Date of last update : 01/18/94

Field	Field Name	Type	Width	Dec	Index
1	SHAP_CODE1	Numeric	1		N
2	SHAP_CODE2	Numeric	1		N
3	ORIEN_CODE	Numeric	1		N
4	PROC_CODE	Numeric	2		N
** Total **			6		

PROSHAP.DBF (Processes based on shapes combination with a joint type)

Structure for database: D:\USER\NEELESH\PROSHAP.DBF
Number of data records: 22
Date of last update : 05/01/94

Field	Field Name	Type	Width	Dec	Index
1	JOINT_CODE	Numeric	1		N
2	SHAPCODE1	Numeric	1		N
3	SHAPCODE2	Numeric	1		N
4	CAW	Character	1		N
5	EGW	Character	1		N
6	ESW	Character	1		N
7	FCAW	Character	1		N
8	MIG	Character	1		N
9	PAW	Character	1		N
10	SAW	Character	1		N
11	SMAW	Character	1		N
12	TIG	Character	1		N
13	BRAZING	Character	1		N
14	DFW	Character	1		N
15	EBW	Character	1		N
16	EXW	Character	1		N
17	FRW	Character	1		N
18	LBW	Character	1		N
19	SOLDERING	Character	1		N
20	USW	Character	1		N
** Total **			21		

PROTHICK.DBF (Working thickness range for processes)

Structure for database: D:\USER\NEELESH\PROTHIC.DBF
Number of data records: 1080
Date of last update : 03/13/94

Field	Field Name	Type	Width	Dec	Index
1	PROC_NAME	Character	15		N
2	MATL_NAME	Character	8		N
3	LOWER_LIM	Numeric	9	5	N
4	UPPER_LIM	Numeric	9	5	N
** Total **			42		

PROPOSI.DBF (Processes based on welding position)

Structure for database: D:\USER\NEELESH\PROPOSI.DBF
Number of data records: 20
Date of last update : 05/27/94

Field	Field Name	Type	Width	Dec	Index
1	PROCESS	Character	15		N
2	FLAT	Character	1		N
3	HORIZONTAL	Character	1		N
4	VERTICAL	Character	1		N
5	OVERHEAD	Character	1		N
** Total **			20		

PROENV.DBF (Processes based on welding environment)

Structure for database: D:\USER\NEELESH\PROENV.DBF
Number of data records: 21
Date of last update : 05/27/94

Field	Field Name	Type	Width	Dec	Index
1	PROCESS	Character	15		N
2	OUTDOOR	Character	1		N
** Total **			17		

PROAPP.DBF (Processes based on welded job application)

Structure for database: D:\USER\NEELESH\PROAPP.DBF
Number of data records: 20
Date of last update : 05/27/94

Field	Field Name	Type	Width	Dec	Index
1	PROCESS	Character	15		N
2	FATIGUE	Character	1		N
** Total **			17		

CRITERIA.DBF (Process/Groove selection criteria)

Structure for database: D:\USER\NEELESH\CRITERIA.DBF
Number of data records: 20
Date of last update : 05/02/94

Field	Field Name	Type	Width	Dec	Index
1	PROCESS	Character	15		N
2	WELD_SPEED	Numeric	2		N
3	DISTORTION	Numeric	2		N
4	COST	Numeric	2		N
** Total **			22		

INPUT3

Structure for database: D:\USER\NEELESH\INPUT3.DBF
Number of data records: 1
Date of last update : 05/03/94

Field	Field Name	Type	Width	Dec	Index
1	GO_PROCESS	Character	15		N
2	FO_PROCESS	Character	15		N
3	JOINT_PREP	Character	2		N
4	JOINT_CODE	Numeric	1		N
5	JOINTTYPE1	Character	6		N
6	WORK_THIC1	Numeric	9	5	N
7	JOINTTYPE2	Character	6		N
8	WORK_THIC2	Numeric	9	5	N
9	JOINTTYPE3	Character	6		N
10	WORK_THIC3	Numeric	9	5	N
11	ORIENTATIO	Character	30		N
12	ORIEN_CODE	Numeric	1		N
** Total **			110		

GRJOIPRE.DBF (Groove joint design and preparation)

Structure for database: D:\USER\NEELESH\GRJOIPRE.DBF
Number of data records: 442
Date of last update : 04/30/94

Field	Field Name	Type	Width	Dec	Index
1	PROCESS	Character	10		N
2	ORIEN_CODE	Numeric	1		N
3	WT_LOWER	Numeric	9	5	N
4	WT_UPPER	Numeric	9	5	N
5	CAT_GROOVE	Character	2		N
6	GRTYPE_PRE	Character	75		N
7	F_LOWER	Numeric	9	5	N
8	F_UPPER	Numeric	9	5	N
9	G_LOWER	Numeric	9	5	N
10	G_UPPER	Numeric	9	5	N
11	RADIUS	Numeric	9	5	N
12	POSI	Character	1		N
13	ALPHA1_LOW	Numeric	3		N
14	ALPHA1_HIG	Numeric	3		N
15	ALPHA2_LOW	Numeric	3		N
16	ALPHA2_HIG	Numeric	3		N
** Total **			165		

ANGRANG.DBF (Included angle for groove joint orientation)

Structure for database: D:\USER\NEELESH\ANGRANG.DBF
Number of data records: 2
Date of last update : 01/04/80

Field	Field Name	Type	Width	Dec	Index
1	ALPHA_LOW	Numeric	3		N
2	ALPHA_HIG	Numeric	3		N
3	BETA_1	Numeric	3		N
4	BETA_2	Numeric	3		N
** Total **			13		

VGRANG.DBF (Included angle for V groove joint)

Structure for database: D:\USER\NEELESH\VGRANG.DBF
Number of data records: 5
Date of last update : 01/20/94

Field	Field Name	Type	Width	Dec	Index
1	POSI_CODE	Numeric	1		N
2	ALPHA_LOW	Numeric	3		N
3	ALPHA_HIG	Numeric	3		N
** Total **			8		

FJOIPRE.DBF (Fillet joint design and preparation)

Structure for database: D:\USER\NEELESH\FJOIPRE.DBF
Number of data records: 104
Date of last update : 03/17/94

Field	Field Name	Type	Width	Dec	Index
1	PROCESS	Character	10		N
2	ORIEN_CODE	Numeric	1		N
3	WT_LOWER	Numeric	9	5	N
4	WT_UPPER	Numeric	9	5	N
5	FTYPE_PRE	Character	80		N
6	FSIZE_CODE	Character	1		N
7	G_LOWER	Numeric	9	5	N
8	G_UPPER	Numeric	9	5	N
9	L_LOWER	Numeric	9	5	N
10	L_UPPER	Numeric	9	5	N
11	ALPHA_LOW	Numeric	3		N
12	ALPHA_HIG	Numeric	3		N
13	BETA	Numeric	3		N
** Total **			156		

INPUT4

Structure for database: D:\USER\NEELESH\INPUT4.DBF
Number of data records: 1
Date of last update : 05/03/94

Field	Field Name	Type	Width	Dec	Index
1	MATERIAL1	Character	40		N
2	NUMBER1	Numeric	3		N
3	NOTATION1	Character	8		N
4	TENS1_KSI	Numeric	5		N
5	MATERIAL2	Character	40		N
6	NUMBER2	Numeric	3		N
7	NOTATION2	Character	8		N
8	TENS2_KSI	Numeric	5		N
9	GO_PROCESS	Character	15		N
10	FO_PROCESS	Character	15		N
11	JOINT_PREP	Character	2		N
12	JOINT_CODE	Numeric	1		N
13	WELDG_POSI	Character	20		N
14	POSI_CODE	Numeric	1		N

ELECTROD.DBF (Consumables and non-consumables electrode specification for some materials)

Structure for database: D:\USER\NEELESH\ELECTROD.DBF
Number of data records: 638
Date of last update : 03/15/94

Field	Field Name	Type	Width	Dec	Index
1	PROC_NAME	Character	15		N
2	NOTATION	Character	8		N
3	NUMBER	Numeric	3		N
4	FILL_MATL	Character	35		N
5	ADVICE	Character	15		N
6	ELECT_NC	Character	15		N
** Total **			92		

INPUT5

Structure for database: D:\USER\NEELESH\INPUT5.DBF
Number of data records: 0
Date of last update : 05/03/94

Field	Field Name	Type	Width	Dec	Index
1	MATERIAL1	Character	40		N
2	NOTATION1	Character	8		N
3	NUMBER1	Numeric	3		N
4	MATERIAL2	Character	40		N
5	NOTATION2	Character	8		N
6	NUMBER2	Numeric	3		N
7	GO_PROCESS	Character	15		N
8	FO_PROCESS	Character	15		N
9	JOINT_PREP	Character	2		N
10	JOINT_CODE	Numeric	1		N
11	JOINTTYPE1	Character	6		N
12	WORK_THIC1	Numeric	9	5	N
13	JOINTTYPE2	Character	6		N
14	WORK_THIC2	Numeric	9	5	N
15	JOINTTYPE3	Character	6		N
16	WORK_THIC3	Numeric	9	5	N
17	WELDG_POSI	Character	20		N
18	POSI_CODE	Numeric	1		N
** Total **			202		

BRAZFILL.DBF (Filler materials & heating methods for brazing)

Structure for database: D:\USER\NEELESH\BRAZFILL.DBF
Number of data records: 456
Date of last update : 03/16/94

Field	Field Name	Type	Width	Dec	Index
1	NOTATION1	Character	8		N
2	NOTATION2	Character	8		N
3	FILL_CODE	Character	6		N
4	HEATMD_R	Character	8		N
5	HEATMD_L	Character	8		N
** Total **			39		

BRAZPARA.DBF (Other welding parameters for brazing)

Structure for database: D:\USER\NEELESH\BRAZPARA.DBF
Number of data records: 23
Date of last update : 03/16/94

Field	Field Name	Type	Width	Dec	Index
1	FILL_MATL	Character	1		N
2	JOINTCLE_L	Numeric	5	3	N
3	JOINTCLE_U	Numeric	5	3	N
4	BRAZTEMP_L	Numeric	4		N
5	BRAZTEMP_U	Numeric	4		N
6	FLUX_AWSSP	Character	36		N
** Total **			56		

SOLDERING.DBF-(Welding parameters for soldering)

Structure for database: D:\USER\NEELESH\SOLDERIN.DBF
Number of data records: 71
Date of last update : 03/16/94

Field	Field Name	Type	Width	Dec	Index
1	NOTATION1	Character	8		N
2	NOTATION2	Character	8		N
3	SO_ABILITY	Character	25		N
4	PREPLATING	Character	1		N
5	SOLDER	Character	25		N
6	SO_TEMP_L	Numeric	3		N
7	SO_TEMP_U	Numeric	3		N
8	ROSIN_F_NA	Character	1		N
9	ROSIN_F_MA	Character	1		N
10	ROSIN_F_A	Character	1		N
11	ORGANIC_F	Character	1		N
12	INORGNIC_F	Character	1		N
13	SPECIAL_F	Character	1		N
** Total **			80		

EBW.DBF (Welding parameters for EBW)

Structure for database: D:\USER\NEELESH\EBW.DBF
Number of data records: 2
Date of last update : 05/02/94

Field	Field Name	Type	Width	Dec	Index
1	WT_LOWER	Numeric	6	2	N
2	WT_UPPER	Numeric	6	2	N
3	PARA_COMB	Character	130		N
** Total **			143		

LBW.DBF (Welding parameters for LBW)

Structure for database: D:\USER\NEELESH\LBW.DBF
Number of data records: 13
Date of last update : 03/16/94

Field	Field Name	Type	Width	Dec	Index
1	WT_LOWER	Numeric	4	2	N
2	WT_UPPER	Numeric	4	2	N
3	O_POWER_L	Numeric	5	2	N
4	O_POWER_U	Numeric	5	2	N
5	LASER_TYPE	Character	15		N
6	GAS_FLOW_S	Character	15		N
7	BEAM_DIA	Numeric	3	1	N
8	BEAM_CHAR	Character	15		N
** Total **			67		

FRW.DBF (Welding parameters for FRW)

Structure for database: D:\USER\NEELESH\FRW.DBF
Number of data records: 17
Date of last update : 03/16/94

Field	Field Name	Type	Width	Dec	Index
1	NOTATION1	Character	8		N
2	NOTATION2	Character	8		N
3	SSPEED_RPM	Numeric	4		N
4	AXFORCE_LB	Numeric	5		N
5	FWHEEL_SIZ	Numeric	5	1	N
** Total **			31		

USW.DBF (Welding parameters for USW)

Structure for database: D:\USER\NEELESH\USW.DBF
Number of data records: 27
Date of last update : 03/16/94

Field	Field Name	Type	Width	Dec	Index
1	NOTATION1	Character	8		N
2	NOTATION2	Character	8		N
3	WT_INCH	Numeric	5	3	N
4	MCPOWER_W	Numeric	4		N
5	CFORCE_L	Numeric	4		N
6	CFORCE_U	Numeric	4		N
** Total **			34		

ESW.DBF (Welding parameters for ESW)

Structure for database: D:\USER\NEELESH\ESW.DBF
Number of data records: 49
Date of last update : 03/16/94

Field	Field Name	Type	Width	Dec	Index
1	WT_INCH	Numeric	7	4	N
2	NO_ELEC	Numeric	1		N
3	DIA_ELEC	Numeric	6	4	N
4	SPACE_ELEC	Numeric	6	4	N
5	TO_CURRENT	Numeric	4		N
6	POLARITY	Character	9		N
7	VOLTAGE	Numeric	2		N
8	OSCI	Character	1		N
9	OSCI_SPEED	Numeric	5	1	N
10	OSCI_STROK	Numeric	6	4	N
11	DWELL_TIME	Numeric	1		N
** Total **			49		

CAW.DBF (Welding parameters for CAW)

Structure for database: D:\USER\NEELESH\CAW.DBF
Number of data records: 8
Date of last update : 03/16/94

Field	Field Name	Type	Width	Dec	Index
1	WT_INCH	Numeric	6	4	N
2	CURRL_AMPS	Numeric	3		N
3	CURRU_AMPS	Numeric	3		N
4	POLARITY	Character	8		N
5	ARCVOLT_L	Numeric	2		N
6	ARCVOLT_U	Numeric	2		N
7	ELEDIAL_IN	Numeric	6	4	N
8	ELEDIAU_IN	Numeric	6	4	N
9	FMDIAL_IN	Numeric	6	4	N
10	FMDIAU_IN	Numeric	6	4	N
** Total **			49		

SAWPARA.DBF (Welding parameters for SAW)

Structure for database: D:\USER\NEELESH\SAWPARA.DBF
Number of data records: 52
Date of last update : 03/17/94

Field	Field Name	Type	Width	Dec	Index
1	NOTATION1	Character	8		N
2	WT_INCH	Numeric	7	5	N
3	NO_PASSES	Character	2		N
4	POLARITY	Character	8		N
5	CURR_AMPS	Character	10		N
6	VOLTAGE	Character	5		N
7	TR_SPEED	Character	5		N
8	DIA_FM	Numeric	7	5	N
** Total **			53		

SMAWWELD.DBF (Welding technique for SMAW)

Structure for database: D:\USER\NEELESH\SMAWWELD.DBF
Number of data records: 8
Date of last update : 03/16/94

Field	Field Name	Type	Width	Dec	Index
1	JOINT_PREP	Character	1		N
2	WELD_POSI	Character	15		N
3	WORK_ANGLE	Character	6		N
4	TRAV_ANGLE	Character	4		N
5	WELD_TECH	Character	8		N
** Total **			35		

SMAWPARA.DBF (Welding parameters for SMAW)

Structure for database: D:\USER\NEELESH\SMAWPARA.DBF
Number of data records: 12
Date of last update : 03/17/94

Field	Field Name	Type	Width	Dec	Index
1	WT_INCH	Numeric	6	4	N
2	NO_PASSES	Character	2		N
3	CURR_AMPS	Character	11		N
4	VOLTAGE	Character	8		N
5	TR_SPEED	Character	10		N
6	DIA_FM	Numeric	7	5	N
** Total **			45		

EGW.DBF-(Welding parameters for EGW)

Structure for database: D:\USER\NEELESH\EGW.DBF
Number of data records: 6
Date of last update : 03/16/94

Field	Field Name	Type	Width	Dec	Index
1	WT_INCH	Numeric	6	4	N
2	CURRL_AMPS	Numeric	3		N
3	CURRU_AMPS	Numeric	3		N
4	POLARITY	Character	8		N
5	VOLTAGE_L	Numeric	2		N
6	VOLTAGE_U	Numeric	2		N
7	ELEC_FEED	Numeric	3		N
8	TRAV_SPEED	Numeric	3	1	N
9	ELEC_EXT	Character	5		N
10	OSCI_DIST	Character	5		N
11	SHIELD_GAS	Character	30		N
** Total **			71		

DFW.DBF (Welding parameters for DFW)

Structure for database: D:\USER\NEELESH\DFW.DBF
Number of data records: 78
Date of last update : 03/16/94

Field	Field Name	Type	Width	Dec	Index
1	NOTATION1	Character	8		N
2	NOTATION2	Character	8		N
3	FILL_MATL	Character	15		N
4	DFW_TL_F	Numeric	4		N
5	DFW_TU_F	Numeric	4		N
6	DFW_PL_KSI	Numeric	6	3	N
7	DFW_PU_KSI	Numeric	6	3	N
8	DFW_TU_MIN	Numeric	7	2	N
9	DFW_TL_MIN	Numeric	7	2	N
10	DFW_ATMOS	Character	15		N
** Total **			81		

FCAWFTPA.DBF (Welding-parameters for fillet joint of FCAW)

Structure for database: D:\USER\NEELESH\FCAWFTPA.DBF
Number of data records: 100
Date of last update : 03/17/94

Field	Field Name	Type	Width	Dec	Index
1	NOTATION1	Character	8		N
2	WT_INCH	Numeric	6	4	N
3	JOINT_PREP	Character	6		N
4	WELD_POSI	Character	15		N
5	PROC_TYPE	Character	20		N
6	NO_PASSES	Numeric	2		N
7	DIA_FM	Numeric	7	5	N
8	POLARITY	Character	8		N
9	CURR_AMPS	Numeric	3		N
10	VOLTAGE	Numeric	5	2	N
11	FM_FDRATE	Numeric	3		N
12	TR_SPEED	Character	2		N
13	GAS_FLRATE	Character	7		N
14	EXT_FM	Numeric	4	2	N
** Total **			97		

FCAWGRPA.DBF (Welding-parameters for groove joint of FCAW)

Structure for database: D:\USER\NEELESH\FCAWGRPA.DBF
Number of data records: 225
Date of last update : 03/17/94

Field	Field Name	Type	Width	Dec	Index
1	NOTATION1	Character	8		N
2	WT_INCH	Numeric	6	4	N
3	JOINT_PREP	Character	25		N
4	WELD_POSI	Character	15		N
5	PROC_TYPE	Character	20		N
6	NO_PASSES	Numeric	2		N
7	DIA_FM	Numeric	7	5	N
8	POLARITY	Character	8		N
9	CURR_AMPS	Numeric	3		N
10	VOLTAGE	Numeric	5	2	N
11	FM_FDRATE	Numeric	3		N
12	TR_SPEED	Character	2		N
13	GAS_FLRATE	Character	7		N
14	EXT_FM	Numeric	4	2	N
** Total **			116		

Structure for database: D:\USER\NEELESH\PAWSHGAS.DBF
Number of data records: 50
Date of last update : 03/17/94

Field	Field Name	Type	Width	Dec	Index
1	NOTATION1	Character	8		N
2	WT_LOWER	Numeric	8	4	N
3	WT_UPPER	Numeric	8	4	N
4	SHIELD_GAS	Character	35		N
5	ORIFIC_GAS	Character	10		N
** Total **			70		

PAWPARA.DBF (Welding parameters for PAW)

Structure for database: D:\USER\NEELESH\PAWPARA.DBF
Number of data records: 47
Date of last update : 03/17/94

Field	Field Name	Type	Width	Dec	Index
1	NOTATION1	Character	8		N
2	WT_INCH	Numeric	7	4	N
3	TR_SPEED	Character	2		N
4	POLARITY	Character	8		N
5	CURR_AMPS	Character	3		N
6	VOLTAGE	Character	2		N
7	ORIFIC_DIA	Numeric	5	3	N
8	SHGAS_FLR	Character	4		N
9	ORGAS_FLR	Character	4		N
10	NO_PASSES	Character	3		N
** Total **			47		

MIGSHGAS.DBF (Shielding gases for MIG_SPRAY & MIG_PULSED)

Structure for database: D:\USER\NEELESH\MIGSHGAS.DBF
Number of data records: 54
Date of last update : 03/17/94

Field	Field Name	Type	Width	Dec	Index
1	NOTATION1	Character	8		N
2	WT_LOWER	Numeric	8	4	N
3	WT_UPPER	Numeric	8	4	N
4	SHIELD_GAS	Character	20		N
5	ADVANTAGE	Character	50		N
** Total **			95		

DMIGSHGAS.DBF (Shielding gases for MIG_SHORT-DIP)

Structure for database: D:\USER\NEELESH\DMIGSHGA.DBF
Number of data records: 44
Date of last update : 03/15/94

Field	Field Name	Type	Width	Dec	Index
1	NOTATION1	Character	8		N
2	WT_LOWER	Numeric	8	4	N
3	WT_UPPER	Numeric	8	4	N

MIGPARA.DBF (Welding parameters for MIG)

Structure for database: D:\USER\NEELESH\MIGPARA.DBF
Number of data records: 73
Date of last update : 03/17/94

Field	Field Name	Type	Width	Dec	Index
1	NOTATION1	Character	8		N
2	WT_INCH	Numeric	7	5	N
3	DIA_FM	Numeric	7	5	N
4	POLARITY	Character	8		N
5	CURR_AMPS	Character	7		N
6	VOLTAGE	Character	5		N
7	FM_FDRATE	Character	7		N
8	GAS_FLRATE	Character	2		N
9	NO_PASSES	Character	5		N
10	TR_SPEED	Character	5		N

OTMIGPARA.DBF (Welding parameters for MIG)

Structure for database: D:\USER\NEELESH\OTMIGPAR.DBF
Number of data records: 23
Date of last update : 05/03/94

Field	Field Name	Type	Width	Dec	Index
1	WELD_POSI	Character	15		N
2	WT_INCH	Numeric	7	5	N
3	DIA_FM	Numeric	7	5	N
4	POLARITY	Character	8		N
5	RBEED_CURR	Character	5		N
6	RBEED_TRSP	Character	10		N
7	FBEED_NO	Character	2		N
8	FBEED_CURR	Character	25		N
9	FBEED_TRSP	Character	25		N
10	TOTAL_BEED	Character	2		N
** Total **			107		

OTTIGPARA.DBF (Welding parameters for TIG)

Structure for database: D:\USER\NEELESH\OTTIGPAR.DBF
Number of data records: 8
Date of last update : 03/17/94

Field	Field Name	Type	Width	Dec	Index
1	WT_INCH	Numeric	7	5	N
2	NO_PASSES	Character	3		N
3	DIA_ELEC	Numeric	7	5	N
4	DIA_FM	Numeric	7	5	N
5	POLARITY	Character	8		N
6	GAS_FLRATE	Character	2		N
7	CURR_AMPS	Character	7		N
8	TR_SPEED	Character	2		N
** Total **			44		

TIGPARA.DBF (Welding parameters for TIG)

Structure for database: D:\USER\NEELESH\TIGPARA.DBF
Number of data records: 130
Date of last update : 03/17/94

Field	Field Name	Type	Width	Dec	Index
1	NOTATION1	Character	8		N
2	WT_LOWER	Numeric	6	4	N
3	WT_UPPER	Numeric	6	4	N
4	DIA_ELEC	Numeric	7	5	N
5	DIA_FM	Numeric	7	5	N
6	NO_PASSES	Numeric	2		N
7	POLARITY	Character	8		N
8	CURR_AMPS	Character	7		N
9	VOLTAGE	Character	2		N
10	TR_SPEED	Character	15		N
11	GAS_FLRATE	Character	4		N
12	PREHTMIN_F	Numeric	3		N
** Total **			76		

APPENDIX–C

KNOWLEDGEBASES

SN.	File Name	Purpose
1.	Material.dbf	Material name, code, tensile strength
2.	Jobshape.dbf	Shape type and code
3.	Joborient.dbf	Orientation type and code
4.	Weldpos.dbf	Welding position type and code
5.	Smpromat.dbf	Processes for similar combination of materials based on it's type
6.	Dspromat.dbf	Processes for dissimilar combination of materials based on it's type
7.	Comshape.dbf	Procedure code based on combination of shapes with an orientation
8.	Proshap.dbf	Processes based on shapes combination with a joint type
9.	Prothick.dbf	Working thickness range for processes
10.	Proposi.dbf	Processes based on welding position
11.	Proenv.dbf	Processes based on welding environment
12.	Proapp.dbf	Processes based on welded job application
13.	Criteria.dbf	Process sequence based on various working criteria
14.	Grjoipre.dbf	Groove joint design and preparations
15.	Vgrang.dbf	Included angle for V groove joint
16.	Angrang.dbf	Included angle for angular orientation of groove joint
17.	Fjoipre.dbf	Fillet joint design and preparations
18.	Electrod.dbf	Consumable electrode and non-consumable electrode specifications for some materials
19.	Brazfill.dbf	Filler materials and heating methods for brazing
20.	Brazpara.dbf	Other welding parameters for brazing
21.	Soldering.dbf	Welding parameters for soldering
22.	Ebw.dbf	Welding parameters for EBW
23.	Lbw.dbf	Welding parameters for LBW
24.	Frw.dbf	Welding parameters for FRW
25.	Usw.dbf	Welding parameters for USW

continued ...

SN.	File Name	Purpose
26.	Esw.dbf	Welding parameters for ESW
27.	Caw.dbf	Welding parameters for CAW
28.	Sawpara.dbf	Welding parameters for SAW
29.	Smawweld.dbf	Welding techniques for SMAW
30.	Smawpara.dbf	Welding parameters for SMAW
31.	Egw.dbf	Welding parameters for EGW
32.	Dfw.dbf	Welding parameters for DFW
33.	Fcawftpa.dbf	Welding parameters for fillet joint for FCAW
34.	Fcawgrpa.dbf	Welding parameters for groove joint for FCAW
35.	Pawshgas.dbf	Shielding gases for PAW
36.	Pawpara.dbf	Welding parameters for PAW
37.	Migshgas.dbf	Shielding gases for MIG-SPRAY, TIG-SPRAY, MIG-PULSED
38.	Dmigshgas.dbf	Shielding gases for MIG-SHORT-DIP AND TIG-SHORT-DIP
39.	Migpara.dbf	Welding parameters for MIG
40.	Otmigpara.dbf	Welding parameters for MIG
41.	Ottigpara.dbf	Welding parameters for TIG
42.	Tigpara.dbf	Welding parameters for TIG

MATERIAL.DBF (Material name,code & tensile strength)

Records	Material (Mat1_name)	Notation (Notation)	Code (Number)	Tensile strength (Tens_ksi)
1	ALUMINIUM	Al	39	
2	ALUMINIUM BRONZE	Cu+Al	84	90
3	ALUMINIUM CAST ALLOY-319	Alal	40	
4	ALUMINIUM CAST ALLUY-333	Alal	41	
5	ALUMINIUM CAST ALLOY-355	Alal	42	
6	ALUMINIUM CAST ALLOY-356	Alal	44	
7	ALUMINIUM CAST ALLOY-413	Alal	45	
8	ALUMINIUM CAST ALLOY-443	Alal	46	
9	ALUMINIUM CAST ALLOY-511	Alal	47	
10	ALUMINIUM CAST ALLOY-512	Alal	48	
11	ALUMINIUM CAST ALLOY-514	Alal	49	
12	ALUMINIUM CAST ALLOY-710	Alal	51	
13	ALUMINIUM CAST ALLOY-711	Alal	52	
14	ALUMINIUM CAST ALLOY-712	Alal	53	
15	ALUMINIUM CAST ALLOY-A514	Alal	50	
16	ALUMINIUM CAST ALLOY-C355	Alal	43	
17	ALUMINIUM WROUGHT ALLOY-1060	Alal	54	
18	ALUMINIUM WROUGHT ALLOY-1100	Alal	55	
19	ALUMINIUM WROUGHT ALLOY-1350	Alal	56	
20	ALUMINIUM WROUGHT ALLOY-2014	Alal	57	
21	ALUMINIUM WROUGHT ALLOY-2024	Alal	58	
22	ALUMINIUM WROUGHT ALLOY-2219	Alal	59	
23	ALUMINIUM WROUGHT ALLOY-3003	Alal	60	
24	ALUMINIUM WROUGHT ALLOY-3004	Alal	61	
25	ALUMINIUM WROUGHT ALLOY-5005	Alal	62	
26	ALUMINIUM WROUGHT ALLOY-5050	Alal	63	
27	ALUMINIUM WROUGHT ALLOY-5052	Alal	64	
28	ALUMINIUM WROUGHT ALLOY-5083	Alal	65	
29	ALUMINIUM WROUGHT ALLOY-5086	Alal	66	
30	ALUMINIUM WROUGHT ALLOY-5154	Alal	67	
31	ALUMINIUM WROUGHT ALLOY-5254	Alal	68	
32	ALUMINIUM WROUGHT ALLOY-5454	Alal	69	
33	ALUMINIUM WROUGHT ALLOY-5456	Alal	70	
34	ALUMINIUM WROUGHT ALLOY-5652	Alal	71	0
35	ALUMINIUM WROUGHT ALLOY-6061	Alal	72	0
36	ALUMINIUM WROUGHT ALLOY-6063	Alal	73	0
37	ALUMINIUM WROUGHT ALLOY-6070	Alal	74	0
38	ALUMINIUM WROUGHT ALLOY-6101	Alal	75	0
39	ALUMINIUM WROUGHT ALLOY-6151	Alal	76	0
40	ALUMINIUM WROUGHT ALLOY-6201	Alal	77	0
41	ALUMINIUM WROUGHT ALLOY-6951	Alal	78	0
42	ALUMINIUM WROUGHT ALLOY-7005	Alal	79	0
43	ALUMINIUM WROUGHT ALLOY-7039	Alal	80	0
44	BERYLLIUM	Be	111	
45	BRASS	Cu+Zn	82	56
46	BRONZE	Cu+Sn	83	100
47	CAST STEEL	CS	5	70
48	CEMENTED CARBIDE	Cc	110	
49	CERAMIC	Cm	108	
50	CHROMIUM	Cr	116	
51	COBALT & IT'S ALLOY	Co	107	
52	COPPER	Cu	81	45
53	CUPRO NICKEL	Cu+Ni	87	78
54	GERMANIUM	Gr	121	
55	GOLD	Au	96	
56	GRAPHITE	Gp	109	
57	GRAY_CAST IRON	GCI	6	30
58	HAFNIUM	Hf	104	
59	HIGH_CARBON STEEL	HCS	3	100
60	INCONEL	Ni+Cr+Fe	94	100
61	IRIDIUM	Ir	106	
62	LEAD	Pb	88	
63	LOW MELTING POINT METAL (TIN,CADMIUM)	Sn,Cd	89	
64	LOW_ALLOY STEEL (C+Mo)	AS	11	80
65	LOW_ALLOY STEEL (Cr+Mo)	AS	12	100
66	LOW_ALLOY STEEL (Mn+Mo)	AS	10	90
67	LOW ALLOY STEEL (Ni+Cr)	AS	13	95

68	LOW_ALLOY STEEL (Ni+Cu)	AS	9	100
69	LOW_ALLOY STEEL (PLAIN Cr)	AS	14	90
70	LOW_ALLUY STEEL (PLAIN Ni)	AS	8	80
71	LOW_CARBON STEEL	LCS	1	60
72	MAGNESIUM & IT'S ALLOY	Mg	90	
73	MALLEABLE_CAST IRON	MCI	7	50
74	MEDIUM_CARBON STEEL	MCS	2	70
75	MOLYBDENUM	Mo	91	
76	MONEL	Ni+Cu	93	90
77	NICKEL	Ni	92	80
78	NICKEL SILVER	Cu+Zn+Ni	86	40
79	NIMONICS	Nm	113	155
80	NIOBIUM OR COLUMBIUM	Nb OR Cb	100	
81	PALLADIUM & IT'S ALLOY	Pd	105	
82	PLATINUM & IT'S ALLOY	Pt	98	
83	RHENIUM	Rn	118	
84	RHODIUM	Rh	117	
85	SILICON	Si	122	
86	SILICON BRONZE	Cu+Si	85	45
87	SILVER	Ag	97	
88	STAINLESS STEEL (AUSTENITIC)-301	SS	20	110
89	STAINLESS STEEL (AUSTENITIC)-302	SS	21	90
90	STAINLESS STEEL (AUSTENITIC)-302B	SS	22	95
91	STAINLESS STEEL (AUSTENITIC)-303	SS	23	90
92	STAINLESS STEEL (AUSTENITIC)-304	SS	24	85
93	STAINLESS STEEL (AUSTENITIC)-304L	SS	25	80
94	STAINLESS STEEL (AUSTENITIC)-305	SS	26	85
95	STAINLESS STEEL (AUSTENITIC)-309	SS	28	90
96	STAINLESS STEEL (AUSTENITIC)-310	SS	29	95
97	STAINLESS STEEL (AUSTENITIC)-316	SS	30	85
98	STAINLESS STEEL (AUSTENITIC)-316Cb	SS	32	80
99	STAINLESS STEEL (AUSTENITIC)-316L	SS	31	78
100	STAINLESS STEEL (AUSTENITIC)-317	SS	33	90
101	STAINLESS STEEL (AUSTENITIC)-317L	SS	34	85
102	STAINLESS STEEL (AUSTENITIC)-318	SS	35	85
103	STAINLESS STEEL (AUSTENITIC)-321	SS	36	87
104	STAINLESS STEEL (AUSTENITIC)-347	SS	37	92
105	STAINLESS STEEL (AUSTENITIC)-348	SS	38	92
106	STAINLESS STEEL (MARTENSITIC)-403	SS	15	75
107	STAINLESS STEEL (MARTENSITIC)-410	SS	16	75
108	STAINLESS STEEL (MARTENSITIC)-416	SS	17	90
109	STAINLESS STEEL (MARTENSITIC)-420	SS	18	95
110	STAINLESS STEEL (MARTENSITIC)-431	SS	19	85
111	STAINLESS STEEL (AUSTENITIC)-308	SS	27	85
112	TANTALUM & IT'S ALLOY	Ta	99	
113	THORIUM	Th	120	
114	TITANIUM	Ti	101	60
115	TITANIUM ALLOY	Tial	102	130
116	TOOL STEEL	TS	4	120
117	TUNGSTEN & IT'S ALLOY	W	112	
118	TUNGSTEN CARBIDE	WC	115	
119	URANIUM & IT'S ALLOY	U	119	
120	VANADIUM	V	114	
121	ZINC	Zn	95	
122	ZIRCONIUM & IT'S ALLOY	Zr	103	
123	INIDIUM	In	123	

JOBSHAPE.DBF (Shape type & code)

Fields name → / Records ↓	Shape Type (Ship_type)	Code (Ship_code)
1	SHEET OR PLATE	1
2	LARGE PIPE OR CYLINDER	2
3	TUBE	3
4	BAR	4

JOBORIENT.DBF (Orientation type & code)

Fields name → / Records ↓	Orientation Type (Orien)	Code (Orien_code)
1	LONGITUDINAL BUTT JOINT	1
2	LONGITUDINAL LAP JOINT	2
3	TEE JOINT	3
4	CORNER JOINT	4
5	ANGULAR JOINT	5
6	ATTACHMENT	6

WELDPOS.DBF (Welding position & code)

Fields name → / Records ↓	Welding position type (Weld_posi)	Code (Posi_code)
1	FLAT(1G)	1
2	HORIZONTAL(2G)	2
3	VERTICAL(3G)	3
4	OVERHEAD(4G)	4
5	NOT SPECIFIC	5

MATERIAL.DBF (Processes for similar combination of materials based on it's type)

Records	Material (Material Name)	Cav Cav	Lgv Lgv	Isv Isv	FCAW	Mig Mig	Pmw Pmw	Smw Smw	Smaw Smaw	Tig Tig	Brazing Brazing	Mfw Mfw	Ehw Ehw	Esw Esw	Frw Frw	Lbw Lbw	Soldering Soldering
1	ALUMINIUM	L	N	N	N	R	R	N	R	R	R	R	N	R	R	R	R
2	ALUMINIUM CAST ALLOY-219	L	N	N	N	L	R	N	R	L	L	R	R	R	R	R	L
3	ALUMINIUM CAST ALLOY-333	L	N	N	N	L	R	N	R	L	L	R	R	R	R	R	L
4	ALUMINIUM CAST ALLOY-355	L	N	N	N	L	R	N	R	L	L	R	R	R	R	R	L
5	ALUMINIUM CAST ALLOY-356	L	N	N	N	L	R	N	R	L	L	R	R	R	R	R	L
6	ALUMINIUM CAST ALLOY-413	L	N	N	N	L	R	N	R	L	L	R	R	R	R	R	L
7	ALUMINIUM CAST ALLOY-443	L	N	N	N	L	R	N	R	L	L	R	R	R	R	R	L
8	ALUMINIUM CAST ALLOY-511	L	N	N	N	L	R	N	R	L	L	R	R	R	R	R	L
9	ALUMINIUM CAST ALLOY-512	L	N	N	N	L	R	N	R	L	L	R	R	R	R	R	L
10	ALUMINIUM CAST ALLOY-514	L	N	N	N	L	R	N	R	L	L	R	R	R	R	R	L
11	ALUMINIUM CAST ALLOY-710	L	N	N	N	L	R	N	R	L	L	R	R	R	R	R	L
12	ALUMINIUM CAST ALLOY-711	L	N	N	N	L	R	N	R	L	L	R	R	R	R	R	L
13	ALUMINIUM CAST ALLOY-712	L	N	N	N	L	R	N	R	L	L	R	R	R	R	R	L
14	ALUMINIUM CAST ALLOY-A514	L	N	N	N	L	R	N	R	L	L	R	R	R	R	R	L
15	ALUMINIUM CAST ALLOY-C355	L	N	N	N	L	R	N	R	L	L	R	R	R	R	R	L
16	ALUMINIUM WROUGHT ALLOY-1060	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
17	ALUMINIUM WROUGHT ALLOY-1100	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
18	ALUMINIUM WROUGHT ALLOY-1350	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
19	ALUMINIUM WROUGHT ALLOY-2014	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
20	ALUMINIUM WROUGHT ALLOY-2024	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
21	ALUMINIUM WROUGHT ALLOY-2219	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
22	ALUMINIUM WROUGHT ALLOY-3003	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
23	ALUMINIUM WROUGHT ALLOY-3004	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
24	ALUMINIUM WROUGHT ALLOY-5005	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
25	ALUMINIUM WROUGHT ALLOY-5050	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
26	ALUMINIUM WROUGHT ALLOY-5052	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
27	ALUMINIUM WROUGHT ALLOY-5083	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
28	ALUMINIUM WROUGHT ALLOY-5086	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
29	ALUMINIUM WROUGHT ALLOY-5154	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
30	ALUMINIUM WROUGHT ALLOY-5254	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
31	ALUMINIUM WROUGHT ALLOY-5454	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
32	ALUMINIUM WROUGHT ALLOY-5456	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
33	ALUMINIUM WROUGHT ALLOY-5652	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
34	ALUMINIUM WROUGHT ALLOY-6061	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
35	ALUMINIUM WROUGHT ALLOY-6063	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
36	ALUMINIUM WROUGHT ALLOY-6070	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
37	ALUMINIUM WROUGHT ALLOY-6101	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
38	ALUMINIUM WROUGHT ALLOY-6151	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
39	ALUMINIUM WROUGHT ALLOY-6201	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
40	ALUMINIUM WROUGHT ALLOY-6951	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
41	ALUMINIUM WROUGHT ALLOY-7005	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
42	ALUMINIUM WROUGHT ALLOY-7039	N	N	N	N	R	R	N	L	R	L	R	L	R	R	R	L
43	ALUMINIUM BRONZE	N	N	N	N	L	R	L	R	L	N	R	R	R	R	R	N
44	BERYLLIUM	N	N	N	N	R	R	N	N	R	N	R	R	N	N	N	N
45	BRASS	L	N	N	N	R	R	L	R	R	R	R	N	R	R	R	R
46	BRONZE	R	N	N	N	L	R	L	R	L	R	R	R	R	R	R	R
47	CAST STEEL	N	L	N	N	R	N	R	R	R	N	N	R	R	N	N	N
48	CEMENTED CARBIDE	N	N	N	N	N	N	N	N	N	L	L	N	N	N	N	L
49	CERAMIC	N	N	N	N	N	N	N	N	N	L	L	N	N	N	N	L
50	CHROMIUM	N	N	N	N	N	R	N	N	R	N	R	N	N	N	N	L
51	COBALT & IT'S ALLOY	N	N	N	N	N	L	N	N	N	R	R	R	N	R	N	N
52	NIOBIUM OR COLUMBIUM	N	N	N	N	N	N	N	N	N	R	R	R	R	R	N	N
53	COPPER	L	N	N	N	R	R	L	L	R	R	R	R	R	R	R	R
54	CUPRO NICKEL	L	N	N	N	L	R	L	R	L	R	N	R	R	R	R	R
55	GOLD	N	N	N	N	N	N	N	N	N	R	R	R	N	N	R	R
56	GRAPHITE	N	N	N	N	N	N	N	N	N	L	N	N	N	N	N	L
57	GRAY_CAST IRON	R	N	R	R	R	L	R	R	L	R	R	N	N	N	N	L
58	HAFNIUM	N	N	N	N	R	R	N	N	R	N	N	R	N	N	R	N
59	HIGH_CARBON STEEL	N	N	L	R	R	R	R	L	L	L	N	L	R	R	L	L
60	INCONEL	N	R	R	N	R	R	R	R	R	L	R	R	R	R	R	L
61	IRIDIUM	L	N	N	N	L	N	N	N	L	N	L	R	R	N	R	R
62	LEAD	N	N	N	N	N	N	N	N	N	N	N	N	N	R	N	R
63	LOW_ALLOY STEEL (C+Mo)	N	L	N	N	N	R	N	R	N	N	N	R	R	R	N	N
64	LOW_ALLOY STEEL (Cr+Mo)	N	L	N	R	R	R	R	R	R	R	N	R	R	R	N	L
65	LOW_ALLOY STEEL (Mn+Mo)	N	L	N	N	N	R	N	R	L	N	N	R	R	R	N	N
66	LOW_ALLOY STEEL (Ni+Cr)	N	R	N	N	R	R	R	R	L	R	N	R	R	R	N	L
67	LOW_ALLOY STEEL (Ni+Cu)	N	L	N	N	R	R	R	R	L	N	N	L	R	R	N	N
68	LOW_ALLOY STEEL (PLAIN Cr)	N	L	N	N	N	R	N	R	R	R	N	L	R	R	N	L
69	LOW_ALLOY STEEL (PLAIN Ni)	N	L	N	N	R	R	R	L	L	R	N	L	R	R	R	N
70	LOW_CARBON STEEL	R	R	R	R	R	R	R	R	L	R	R	R	R	R	R	R
71	LOW MELTING POINT METAL (TIN.CADMIUM)	N	N	N	N	N	N	N	N	N	N	N	N	N	R	N	R
72	MAGNESIUM & IT'S ALLOY	N	N	N	N	R	L	N	N	R	L	R	L	R	R	R	L
73	MALLEABLE_CAST IRON	R	N	R	R	R	L	R	R	L	R	R	N	N	N	N	L
74	MEDIUM_CARBON STEEL	R	R	R	R	R	R	R	R	L	L	N	R	R	R	L	R
75	MOLYBDENUM	L	N	N	N	R	N	N	N	R	R	R	R	N	R	R	N
76	MONEL	R	R	R	N	L	R	R	R	L	R	R	R	R	R	R	L
77	NICKEL	R	R	R	N	L	R	R	R	L	N	R	R	R	R	R	R
78	NICKEL SILVER	N	N	N	N	L	R	L	L	L	R	N	N	R	L	R	R
79	NIMONICS	N	N	N	N	N	N	N	N	N	R	R	N	R	R	R	R
80	NIOBIUM	L	N	N	N	N	N	N	N	R	R	R	R	R	R	N	R
81	PALLADIUM & IT'S ALLOY	L	N	N	N	L	N	N	N	L	N	L	R	R	N	R	R
82	PLATINUM & IT'S ALLOY	L	N	N	N	L	N	N	N	L	N	L	R	R	N	R	R
83	RHENIUM	N	N	N	N	N	N	N	N	N	N	N	R	N	N	N	N

84	RHODIUM	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	R	N
85	SILICON	N	N	N	N	R	R	N	R	R	R	R	N	N	N	N	N	N	N
86	SILICON BRONZE	L	N	N	N	R	R	R	R	R	R	R	R	R	R	R	L	R	R
87	SILVER	N	R	L	R	R	R	L	R	R	R	R	R	R	R	R	L	R	R
88	STAINLESS STEEL (AUSTENITIC)-301	N	N	N	R	R	R	R	R	R	R	R	R	R	R	R	L	R	R
89	STAINLESS STEEL (AUSTENITIC)-302	N	R	L	R	R	R	R	R	R	R	R	R	R	R	R	L	R	R
90	STAINLESS STEEL (AUSTENITIC)-302B	N	R	L	R	R	R	R	R	R	R	R	R	R	R	R	L	R	R
91	STAINLESS STEEL (AUSTENITIC)-303	N	R	L	R	R	R	R	R	R	R	R	R	R	R	R	L	R	R
92	STAINLESS STEEL (AUSTENITIC)-304	N	R	L	R	R	R	R	R	R	R	R	R	R	R	R	L	R	R
93	STAINLESS STEEL (AUSTENITIC)-304L	N	R	L	R	R	R	R	R	R	R	R	R	R	R	R	L	R	R
94	STAINLESS STEEL (AUSTENITIC)-305	N	R	L	R	R	R	R	R	R	R	R	R	R	R	R	L	R	R
95	STAINLESS STEEL (AUSTENITIC)-308	N	R	L	R	R	R	R	R	R	R	R	R	R	R	R	L	R	R
96	STAINLESS STEEL (AUSTENITIC)-309	N	R	L	R	R	R	R	R	R	R	R	R	R	R	R	L	R	R
97	STAINLESS STEEL (AUSTENITIC)-310	N	R	L	R	R	R	R	R	R	R	R	R	R	R	R	L	R	R
98	STAINLESS STEEL (AUSTENITIC)-316	N	R	L	R	R	R	R	R	R	R	R	R	R	R	R	L	R	R
99	STAINLESS STEEL (AUSTENITIC)-316Cb	N	R	L	R	R	R	R	R	R	R	R	R	R	R	R	L	R	R
100	STAINLESS STEEL (AUSTENITIC)-316L	N	R	L	R	R	R	R	R	R	R	R	R	R	R	R	L	R	R
101	STAINLESS STEEL (AUSTENITIC)-317	N	R	L	R	R	R	R	R	R	R	R	R	R	R	R	L	R	R
102	STAINLESS STEEL (AUSTENITIC)-317L	N	R	L	R	R	R	R	R	R	R	R	R	R	R	R	L	R	R
103	STAINLESS STEEL (AUSTENITIC)-318	N	R	L	R	R	R	R	R	R	R	R	R	R	R	R	L	R	R
104	STAINLESS STEEL (AUSTENITIC)-321	N	R	L	R	R	R	R	R	R	R	R	R	R	R	R	L	R	R
105	STAINLESS STEEL (AUSTENITIC)-347	N	R	L	R	R	R	R	R	R	R	R	R	R	R	R	L	R	R
106	STAINLESS STEEL (AUSTENITIC)-348	N	R	L	R	R	R	R	R	R	R	R	R	R	R	R	L	R	R
107	STAINLESS STEEL (MARTENSITIC)-403	N	N	L	R	R	R	R	R	R	R	R	R	R	R	R	L	R	R
108	STAINLESS STEEL (MARTENSITIC)-410	N	N	L	R	R	R	R	R	R	R	R	R	R	R	R	L	R	R
109	STAINLESS STEEL (MARTENSITIC)-416	N	N	L	R	R	R	R	R	R	R	R	R	R	R	R	L	R	R
110	STAINLESS STEEL (MARTENSITIC)-420	N	N	L	R	R	R	R	R	R	R	R	R	R	R	R	L	R	R
111	STAINLESS STEEL (MARTENSITIC)-431	N	N	L	R	R	R	R	R	R	R	R	R	R	R	R	L	R	R
112	TANTALUM & IT'S ALLOY	L	N	N	N	N	N	N	N	N	N	N	N	N	N	N	L	N	N
113	THORIUM	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	L	N	N
114	TITANIUM	N	N	N	N	R	L	L	L	L	L	L	L	L	L	L	L	N	N
115	TITANIUM ALLOY	N	N	N	N	R	N	N	N	N	N	N	N	N	N	N	L	N	N
116	TOOL STEEL	N	N	N	N	L	N	N	N	N	N	N	N	N	N	N	L	N	N
117	TUNGSTEN & IT'S ALLOY	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	L	N	N
118	TUNGSTEN CARBIDE	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	L	N	N
119	URANIUM & IT'S ALLOY	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	L	N	N
120	VANADIUM	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	L	N	N
121	ZINC	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	L	N	N
122	ZIRCONIUM & IT'S ALLOY	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	L	N	N
123	GERMANIUM	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	L	N	N
124	INIDIUM	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	L	N	N

DSPROMAT.DBT (Processes for dissimilar combination

Fields name → / Records ↓	(Material1)	(Material2)	Processes (Process)
1	Al	Zr	DFU
2	Al	Zn	NW
3	Al	V	D
4	Al	U	D
5	Al	W	FU
6	Al	Tial	BDPFU
7	Al	Ti	BDPFU
8	Al	Sn	EU
9	Al	Th	NW
10	Al	Ta	PU
11	Al	TS	NW
12	Al	SS	BDPF
13	Al	LCS	BDPF
14	Al	MCS	BDPF
15	Al	HCS	BDPF
16	Al	AS	BDPF
17	Al	Ag	DEPU
18	Al	Si	U
19	Al	Rh	E
20	Al	Pt	U
21	Al	Pd	U
22	Al	Nm	DPU
23	Al	Cd	EU
24	Al	Rn	E
25	Al	Ir	U
26	Al	Ni+Cr+Fe	DPU
27	Al	Cu+Zn+Ni	DPU
28	Al	Ni	DPFU
29	Al	Ni+Cu	DPU
30	Al	Mo	U
31	Al	Mg	DEPFU
32	Al	Pb	NW
33	Al	Gp	NW
34	Al	Au	U
35	Al	Hf	DFU
36	Al	Gr	U
37	Al	Cu+Ni	DEPU
38	Al	Cu	DEPFU
39	Al	Nb OR Cb	P
40	Al	Co	NW
41	Al	Cr	NW
42	Al	Cm	F
43	Al	GCI	U
44	Al	MCI	U
45	Al	CS	BDPF
46	Al	WC	F
47	Al	Cc	NW
48	Al	Cu+Sn	DEPU
49	Al	Cu+Si	DEPU
50	Al	Cu+Al	DEPU
51	Al	Cu+Zn	DEPFU
52	Al	Be	BDEU
53	Al	Alal	BDPFU
54	Alal	Zr	DU
55	Alal	Zn	NW
56	Alal	V	D
57	Alal	U	D
58	Alal	W	U
59	Alal	Tial	BDPU
60	Alal	Ti	BDPU
61	Alal	Sn	EU
62	Alal	Cd	EU
63	Alal	Th	NW
64	Alal	Ta	PU
65	Alal	TS	NW
66	Alal	SS	BDPF
67	Alal	LCS	BDPF
68	Alal	HCS	BDPF
69	Alal	MCS	BDPF

70	Alal	AS	BDPF
71	Alal	Ag	DEPU
72	Alal	Rn	E
73	Alal	Rh	E
74	Alal	Si	U
75	Alal	Pt	U
76	Alal	Pd	U
77	Alal	Nm	DPU
78	Alal	Ni+Cr+Fe	DPU
79	Alal	Cu+Zn+Ni	DPU
80	Alal	Ni	DPU
81	Alal	Ni+Cu	DPU
82	Alal	Ir	U
83	Alal	Mo	U
84	Alal	Mg	DEPFU
85	Alal	Pb	NW
86	Alal	Gp	NW
87	Alal	Au	U
88	Alal	Hf	DU
89	Alal	Gr	U
90	Alal	Cu+Ni	DEP
91	Alal	Cu	DEPF
92	Alal	Nb OR Cb	P
93	Alal	Co	NW
94	Alal	Cr	NW
95	Alal	Cm	F
96	Alal	GCI	U
97	Alal	MCI	U
98	Alal	CS	U
99	Alal	WC	NW
100	Alal	Cu+Si	DEPU
101	Alal	Cu+Al	DEPU
102	Alal	Cu+Sn	DEPU
103	Alal	Cu+Zn	DEPU
104	Alal	Be	BDEU
105	Be	Zr	NW
106	Be	Zn	NW
107	Be	V	NW
108	Be	U	NW
109	Be	W	NW
110	Be	Tial	BU
111	Be	Ti	BU
112	Be	Sn	E
113	Be	Cd	E
114	Be	Th	NW
115	Be	Ta	NW
116	Be	TS	NW
117	Be	SS	BD
118	Be	LCS	B
119	Be	HCS	B
120	Be	MCS	B
121	Be	AS	B
122	Be	Ag	D
123	Be	Si	NW
124	Be	Rn	NW
125	Be	Rh	NW
126	Be	Pt	NW
127	Be	Pd	NW
128	Be	Nm	B
129	Be	Ni+Cr+Fe	B
130	Be	Cu+Zn+Ni	B
131	Be	Ni	B
132	Be	Ni+Cu	B
133	Be	Ir	NW
134	Be	Mo	NW
135	Be	Mg	NW
136	Be	Pb	NW
137	Be	Gp	B
138	Be	Au	D
139	Be	Hf	NW
140	Be	Gr	NW
141	Be	Cu+Ni	DU

142	Be	Cu	DU
143	Be	Nb OR Cb	NW
144	Be	Co	NW
145	Be	Cr	NW
146	Be	Cm	B
147	Be	GCI	BU
148	Be	MCI	BU
149	Be	WC	NW
150	Be	Cc	NW
151	Be	Cu+Si	DU
152	Be	Cu+Sn	DU
153	Be	Cu+Al	DU
154	Cu+Zn	Zr	DU
155	Cu+Zn	Zn	NW
156	Cu+Zn	V	D
157	Cu+Zn	U	NW
158	Cu+Zn	W	BDEU
159	Cu+Zn	Tial	BDPU
160	Cu+Zn	Ti	BDPU
161	Cu+Zn	Sn	E
162	Cu+Zn	Cd	E
163	Cu+Zn	Th	NW
164	Cu+Zn	Ta	BEPU
165	Cu+Zn	TS	B
166	Cu+Zn	SS	BDP
167	Cu+Zn	LCS	BDP
168	Cu+Zn	MCS	BDP
169	Cu+Zn	HCS	BDP
170	Cu+Zn	AS	BDP
171	Cu+Zn	Ag	EPDU
172	Cu+Zn	Si	NW
173	Cu+Zn	Rn	E
174	Cu+Zn	Rh	E
175	Cu+Zn	Pt	EU
176	Cu+Zn	Pd	U
177	Cu+Zn	Nm	BDEPU
178	Cu+Zn	Ni+Cr+Fe	BDEPU
179	Cu+Zn	Cu+Zn+Ni	BDEPU
180	Cu+Zn	Ni	BDEPU
181	Cu+Zn	Ni+Cu	BDEPU
182	Cu+Zn	Ir	U
183	Cu+Zn	Mo	BDEU
184	Cu+Zn	Mg	U
185	Cu+Zn	Pb	NW
186	Cu+Zn	Gp	B
187	Cu+Zn	Au	DEPU
188	Cu+Zn	Hf	DU
189	Cu+Zn	Gr	NW
190	Cu+Zn	Cu+Ni	BDP
191	Cu+Zn	Cu	BDP
192	Cu+Zn	Nb OR Cb	BDEP
193	Cu+Zn	Co	E
194	Cu+Zn	Cr	NW
195	Cu+Zn	Cm	BD
196	Cu+Zn	GCI	BEU
197	Cu+Zn	MCI	BEU
198	Cu+Zn	CS	BDP
199	Cu+Zn	WC	NW
200	Cu+Zn	Cc	NW
201	Cu+Zn	Cu+Sn	BPDU
202	Cu+Sn	Zr	DU
203	Cu+Sn	Zn	NW
204	Cu+Sn	V	NW
205	Cu+Sn	U	NW
206	Cu+Sn	W	BDEU
207	Cu+Sn	Tial	BDPU
208	Cu+Sn	Ti	BDPU
209	Cu+Sn	Sn	E
210	Cu+Sn	Cd	E
211	Cu+Sn	Th	NW
212	Cu+Sn	Ta	BEPU
213	Cu+Sn	TS	B

214	Cu+Sn	SS	BDP
215	Cu+Sn	LCS	BDPF
216	Cu+Sn	MCS	BDPF
217	Cu+Sn	HCS	BDPF
218	Cu+Sn	AS	BDP
219	Cu+Sn	CS	BDP
220	Cu+Sn	Ag	EPDU
221	Cu+Sn	Si	NW
222	Cu+Sn	Rn	E
223	Cu+Sn	Rh	E
224	Cu+Sn	Pt	EU
225	Cu+Sn	Pd	U
226	Cu+Sn	Ir	U
227	Cu+Sn	Nm	BDEPU
228	Cu+Sn	Ni+Cr+Fe	BDEPU
229	Cu+Sn	Cu+Zn+Ni	BDEPU
230	Cu+Sn	Ni	BDEPU
231	Cu+Sn	Ni+Cu	BDEPU
232	Cu+Sn	Mo	BDEU
233	Cu+Sn	Mg	U
234	Cu+Sn	Pb	NW
235	Cu+Sn	Gp	B
236	Cu+Sn	Au	DEPU
237	Cu+Sn	Hf	DU
238	Cu+Sn	Gr	NW
239	Cu+Sn	Cu+Ni	BDP
240	Cu+Sn	Cu	BDP
241	Cu+Sn	Nb OR Cb	BDEP
242	Cu+Sn	Co	E
243	Cu+Sn	Cr	NW
244	Cu+Sn	Cm	BD
245	Cu+Sn	GCI	BEU
246	Cu+Sn	MCI	BEU
247	Cu+Sn	WC	NW
248	Cu+Sn	Cc	NW
249	*Cu+Sn	Cu+Si	BDPFUSL
250	Cu+Sn	Cu+Al	BDPFUSL
251	Cu+Si	Zr	DU
252	Cu+Si	Hf	DU
253	Cu+Si	Zn	NW
254	Cu+Si	V	NW
255	Cu+Si	U	NW
256	Cu+Si	Tial	BDPU
257	Cu+Si	W	BDEU
258	Cu+Si	Ti	BDPU
259	Cu+Si	Sn	E
260	Cu+Si	Cd	E
261	Cu+Si	Th	NW
262	Cu+Si	Ta	BEPU
263	Cu+Si	TS	B
264	Cu+Si	SS	BDP
265	Cu+Si	LCS	BDPF
266	Cu+Si	MCS	BDPF
267	Cu+Si	HCS	BDPF
268	Cu+Si	AS	BDP
269	Cu+Si	CS	BDP
270	Cu+Si	Ag	EPDU
271	Cu+Si	Si	NW
272	Cu+Si	Rn	E
273	Cu+Si	Rh	E
274	Cu+Si	Pt	EU
275	Cu+Si	Pd	U
276	Cu+Si	Ir	U
277	Cu+Si	Nm	BDEPU
278	Cu+Si	Ni+Cr+Fe	BDEPU
279	Cu+Si	Cu+Zn+Ni	BDEPU
280	Cu+Si	Ni	BDEPU
281	Cu+Si	Ni+Cu	BDEPU
282	Cu+Si	Mo	BDEU
283	Cu+Si	Mg	U
284	Cu+Si	Pb	NW
285	Cu+Si	Gp	B

286	Cu+Si	Au	DEPU
287	Cu+Si	Gr	NW
288	Cu+Si	Cu+Ni	BDP
289	Cu+Si	Cu	BDP
290	Cu+Si	Nb OR Cb	BDEP
291	Cu+Si	Co	E
292	Cu+Si	Cr	NW
293	Cu+Si	Cm	BD
294	Cu+Si	GCI	BEU
295	Cu+Si	MCI	BEU
296	Cu+Si	WC	NW
297	Cu+Si	Cc	NW
298	Cu+Si	Cu+Al	BDPFUSL
299	Cu+Al	Zr	DU
300	Cu+Al	Hf	DU
301	Cu+Al	Zn	NW
302	Cu+Al	V	NW
303	Cu+Al	U	NW
304	Cu+Al	W	BDEU
305	Cu+Al	Tial	BDPU
306	Cu+Al	Ti	BDPU
307	Cu+Al	Sn	E
308	Cu+Al	Cd	E
309	Cu+Al	Th	NW
310	Cu+Al	Ta	BEPU
311	Cu+Al	TS	B
312	Cu+Al	SS	BDP
313	Cu+Al	LCS	BDPF
314	Cu+Al	MCS	BDPF
315	Cu+Al	HCS	BDPF
316	Cu+Al	AS	BDP
317	Cu+Al	CS	BDP
318	Cu+Al	Ag	EPDU
319	Cu+Al	Si	NW
320	Cu+Al	Rn	E
321	Cu+Al	Rh	E
322	Cu+Al	Pt	EU
323	Cu+Al	Pd	U
324	Cu+Al	Ir	U
325	Cu+Al	Nm	BDEPU
326	Cu+Al	Ni+Cr+Fe	BDEPU
327	Cu+Al	Cu+Zn+Ni	BDEPU
328	Cu+Al	Ni	BDEPU
329	Cu+Al	Ni+Cu	BDEPU
330	Cu+Al	Mo	BDEU
331	Cu+Al	Mg	U
332	Cu+Al	Pb	NW
333	Cu+Al	Gp	B
334	Cu+Al	Au	DEPU
335	Cu+Al	Gr	NW
336	Cu+Al	Cu+Ni	BDP
337	Cu+Al	Cu	BDP
338	Cu+Al	Nb OR Cb	BDEP
339	Cu+Al	Co	E
340	Cu+Al	Cr	NW
341	Cu+Al	Cm	BD
342	Cu+Al	GCI	BEU
343	Cu+Al	MCI	BEU
344	Cu+Al	WC	NW
345	Cu+Al	Cc	NW
346	Cc	Zr	NW
347	Cc	Hf	NW
348	Cc	V	NW
349	Cc	Zn	NW
350	Cc	U	NW
351	Cc	W	NW
352	Cc	Tial	NW
353	Cc	Ti	NW
354	Cc	Sn	NW
355	Cc	Cd	NW
356	Cc	Th	NW
357	Cc	Ta	NW

358	Cc	TS	F
359	Cc	SS	NW
360	Cc	LCS	F
361	Cc	MCS	F
362	Cc	HCS	F
363	Cc	AS	NW
364	Cc	CS	NW
365	Cc	Ag	NW
366	Cc	Si	NW
367	Cc	Rn	NW
368	Cc	Rh	NW
369	Cc	Pt	NW
370	Cc	Pd	NW
371	Cc	Ir	NW
372	Cc	Nm	D
373	Cc	Ni+Cr+Fe	D
374	Cc	Cu+Zn+Ni	NW
375	Cc	Ni	D
376	Cc	Ni+Cu	D
377	Cc	Mo	NW
378	Cc	Mg	NW
379	Cc	Pb	NW
380	Cc	Gp	NW
381	Cc	Au	NW
382	Cc	Gr	NW
383	Cc	Cu+Ni	NW
384	Cc	Cu	NW
385	Cc	Nb OR Cb	D
386	Cc	Co	NW
387	Cc	Cr	NW
388	Cc	Cm	D
389	Cc	GCI	NW
390	Cc	MCI	NW
391	Cc	WC	NW
392	WC	Zr	NW
393	WC	Hf	NW
394	WC	Zn	NW
395	WC	V	NW
396	WC	U	NW
397	WC	W	NW
398	WC	Ti	NW
399	WC	Tial	NW
400	WC	Sn	NW
401	WC	Cd	NW
402	WC	Th	NW
403	WC	Ta	NW
404	WC	TS	NW
405	WC	SS	NW
406	WC	LCS	NW
407	WC	MCS	NW
408	WC	HCS	NW
409	WC	AS	NW
410	WC	CS	NW
411	WC	Ag	NW
412	WC	Si	NW
413	WC	Rn	NW
414	WC	Rh	NW
415	WC	Pt	NW
416	WC	Pd	NW
417	WC	Ir	NW
418	WC	Nm	D
419	WC	Ni+Cr+Fe	D
420	WC	Cu+Zn+Ni	NW
421	WC	Ni	D
422	WC	Ni+Cu	D
423	WC	Mo	NW
424	WC	Mg	NW
425	WC	Pb	NW
426	WC	Gp	NW
427	WC	Au	NW
428	WC	Gr	NW
429	WC	Cu+Ni	NW

430	WC	Cu	NW
431	WC	Nb OR Cb	D
432	WC	Co	NW
433	WC	Cr	NW
434	WC	Cm	D
435	WC	GCI	NW
436	WC	MCI	NW
437	MCI	Zr	BU
438	MCI	Hf	BU
439	MCI	Zn	NW
440	MCI	V	B
441	MCI	U	NW
442	MCI	W	BD
443	MCI	Ti	BU
444	MCI	Tial	BU
445	MCI	Sn	NW
446	MCI	Cd	NW
447	MCI	Th	NW
448	MCI	Ta	B
449	MCI	TS	B
450	MCI	SS	BD
451	MCI	LCS	BD
452	MCI	MCS	BD
453	MCI	HCS	BD
454	MCI	AS	BD
455	MCI	CS	BD
456	MCI	Ag	EU
457	MCI	Si	NW
458	MCI	Rn	NW
459	MCI	Rh	NW
460	MCI	Pt	EU
461	MCI	Pd	U
462	MCI	Ir	U
463	MCI	Nm	BDEU
464	MCI	Ni+Cr+Fe	BDEU
465	MCI	Cu+Zn+Ni	BEU
466	MCI	Ni	BDEU
467	MCI	Ni+Cu	BDEU
468	MCI	Mo	BEU
469	MCI	Mg	E
470	MCI	Pb	NW
471	MCI	Gp	NW
472	MCI	Au	EU
473	MCI	Gr	NW
474	MCI	Cu+Ni	BEU
475	MCI	Cu	BEU
476	MCI	Nb OR Cb	B
477	MCI	Co	E
478	MCI	Cr	NW
479	MCI	Cm	NW
480	MCI	GCI	BDU
481	GCI	Zr	BU
482	GCI	Hf	BU
483	GCI	Zn	NW
484	GCI	V	BW
485	GCI	U	NW
486	GCI	W	BD
487	GCI	Ti	BU
488	GCI	Tial	BU
489	GCI	Sn	NW
490	GCI	Cd	NW
491	GCI	Th	NW
492	GCI	Ta	B
493	GCI	TS	B
494	GCI	SS	BD
495	GCI	LCS	BD
496	GCI	MCS	BD
497	GCI	HCS	BD
498	GCI	AS	BD
499	GCI	CS	BD
500	GCI	Ag	EU
501	GCI	Si	NW

502	GCI	Rn	NW
503	GCI	Rh	NW
504	GCI	Pt	EU
505	GCI	Pd	U
506	GCI	Ir	U
507	GCI	Nm	BDEU
508	GCI	Ni+Cr+Fe	BDEU
509	GCI	Cu+Zn+Ni	BEU
510	GCI	Ni	BDEU
511	GCI	Ni+Cu	BDEU
512	GCI	Mo	BEU
513	GCI	Mg	E
514	GCI	Pb	NW
515	GCI	Gp	NW
516	GCI	Au	EU
517	GCI	Gr	NW
518	GCI	Cu+Ni	BEU
519	GCI	Cu	BEU
520	GCI	Nb OR Cb	B
521	GCI	Co	E
522	GCI	Cr	NW
523	GCI	Cm	NW
524	Cm	Zr	BD
525	Cm	Hf	BD
526	Cm	Zn	NW
527	Cm	V	B
528	Cm	U	NW
529	Cm	W	D
530	Cm	Ti	BD
531	Cm	Tial	BD
532	Cm	Sn	NW
533	Cm	Cd	NW
534	Cm	Th	NW
535	Cm	Ta	D
536	Cm	TS	NW
537	Cm	SS	D
538	Cm	LCS	D
539	Cm	MCS	D
540	Cm	HCS	D
541	Cm	AS	D
542	Cm	CS	D
543	Cm	Ag	NW
544	Cm	Si	NW
545	Cm	Rn	NW
546	Cm	Rh	NW
547	Cm	Pt	NW
548	Cm	Pd	D
549	Cm	Ir	D
550	Cm	Nm	BD
551	Cm	Ni+Cr+Fe	BD
552	Cm	Cu+Zn+Ni	BD
553	Cm	Ni	BD
554	Cm	Ni+Cu	BD
555	Cm	Mo	NW
556	Cm	Mg	NW
557	Cm	Pb	NW
558	Cm	Gp	B
559	Cm	Au	NW
560	Cm	Gr	NW
561	Cm	Cu+Ni	BD
562	Cm	Cu	BD
563	Cm	Co	NW
564	Cm	Cr	D
565	Cr	Zr	NW
566	Cr	Hf	NW
567	Cr	Zn	NW
568	Cr	V	NW
569	Cr	U	NW
570	Cr	W	D
571	Cr	Ti	NW
572	Cr	Tial	NW
573	Cr	Sn	NW

574	Cr	Cd	NW
575	Cr	Th	NW
576	Cr	Ta	NW
577	Cr	TS	NW
578	Cr	SS	NW
579	Cr	LCS	NW
580	Cr	MCS	NW
581	Cr	HCS	NW
582	Cr	AS	NW
583	Cr	CS	NW
584	Cr	Ag	NW
585	Cr	Si	NW
586	Cr	Rn	NW
587	Cr	Rh	NW
588	Cr	Pt	NW
589	Cr	Pd	NW
590	Cr	Ir	NW
591	Cr	Nm	NW
592	Cr	Ni+Cr+Fe	NW
593	Cr	Cu+Zn+Ni	NW
594	Cr	Ni	NW
595	Cr	Ni+Cu	NW
596	Cr	Mo	NW
597	Cr	Mg	NW
598	Cr	Pb	NW
599	Cr	Gp	NW
600	Cr	Au	NW
601	Cr	Cu+Ni	NW
602	Cr	Cu	NW
603	Cr	Nb OR Cb	NW
604	Cr	Co	NW
605	Cr	Cr	D
606	Co	Zr	NW
607	Co	Hf	NW
608	Co	Zn	NW
609	Co	V	NW
610	Co	U	NW
611	Co	W	NW
612	Co	Ti	NW
613	Co	Tial	NW
614	Co	Sn	NW
615	Co	Cd	NW
616	Co	Th	NW
617	Co	Ta	NW
618	Co	TS	NW
619	Co	SS	DP
620	Co	LCS	F
621	Co	MCS	F
622	Co	HCS	F
623	Co	AS	PF
624	Co	CS	PF
625	Co	Ag	E
626	Co	Si	NW
627	Co	Rn	E
628	Co	Rh	E
629	Co	Pt	E
630	Co	Pd	D
631	Co	Ir	D
632	Co	Nm	DE
633	Co	Ni+Cr+Fe	DE
634	Co	Cu+Zn+Ni	E
635	Co	Ni	DE
636	Co	Ni+Cu	DE
637	Co	Mo	NW
638	Co	Mg	NW
639	Co	Pb	NW
640	Co	Gp	NW
641	Co	Au	E
642	Co	Gr	NW
643	Co	Cu+Ni	E
644	Co	Cu	E
645	Co	Nb OR Cb	NW

646	Nb OR Cb	Zr	DE
647	Nb OR Cb	Hf	DE
648	Nb OR Cb	Zn	NW
649	Nb OR Cb	V	D
650	Nb OR Cb	U	NW
651	Nb OR Cb	W	DE
652	Nb OR Cb	Ti	DEP
653	Nb OR Cb	Tial	DEP
654	Nb OR Cb	Sn	NW
655	Nb OR Cb	Cd	NW
656	Nb OR Cb	Th	NW
657	Nb OR Cb	Ta	DEP
658	Nb OR Cb	TS	NW
659	Nb OR Cb	SS	BDP
660	Nb OR Cb	LCS	BDP
661	Nb OR Cb	MCS	BDP
662	Nb OR Cb	HCS	BDP
663	Nb OR Cb	AS	BD
664	Nb OR Cb	CS	BD
665	Nb OR Cb	Ag	E
666	Nb OR Cb	Si	NW
667	Nb OR Cb	Rn	NW
668	Nb OR Cb	Rh	NW
669	Nb OR Cb	Pt	P
670	Nb OR Cb	Pd	NW
671	Nb OR Cb	Ir	NW
672	Nb OR Cb	Nm	BD
673	Nb OR Cb	Ni+Cr+Fe	BD
674	Nb OR Cb	Cu+Zn+Ni	BD
675	Nb OR Cb	Ni	BD
676	Nb OR Cb	Ni+Cu	BD
677	Nb OR Cb	Mo	DE
678	Nb OR Cb	Mg	E
679	Nb OR Cb	Pb	NW
680	Nb OR Cb	Gp	B
681	Nb OR Cb	Au	E
682	Nb OR Cb	Gr	NW
683	Nb OR Cb	Cu+Ni	BDEP
684	Nb OR Cb	Cu	BDEP
685	Cu	Zr	DFU
686	Cu	Hf	DFU
687	Cu	Zn	NW
688	Cu	V	D
689	Cu	U	NW
690	Cu	W	BDEU
691	Cu	Ti	BDPFU
692	Cu	Tial	BDPU
693	Cu	Sn	E
694	Cu	Cd	E
695	Cu	Th	NW
696	Cu	Ta	BEPU
697	Cu	TS	B
698	Cu	SS	BDPF
699	Cu	LCS	BDPF
700	Cu	MCS	BDPF
701	Cu	HCS	BDPF
702	Cu	AS	BDP
703	Cu	CS	BDP
704	Cu	Ag	EDPU
705	Cu	Si	NW
706	Cu	Rn	E
707	Cu	Rh	E
708	Cu	Pt	EU

709	Cu	Pd	U
710	Cu	Ir	U
711	Cu	Nm	BDEPU
712	Cu	Ni+Cr+Fe	BDEPU
713	Cu	Cu+Zn+Ni	BDEPU
714	Cu	Ni	BDEPU
715	Cu	Ni+Cu	BDEPU
716	Cu	Mo	BDEU
717	Cu	Mg	U
718	Cu	Pb	NW
719	Cu	Gp	B
720	Cu	Au	DEPU
721	Cu	Gr	NW
722	Cu	Cu+Ni	BDPU
723	Cu+Ni	Zr	DU
724	Cu+Ni	Hf	DU
725	Cu+Ni	Zn	NW
726	Cu+Ni	V	D
727	Cu+Ni	U	NW
728	Cu+Ni	W	BDEU
729	Cu+Ni	Ti	BDPU
730	Cu+Ni	Tial	BDPU
731	Cu+Ni	Sn	E
732	Cu+Ni	Cd	E
733	Cu+Ni	Th	NW
734	Cu+Ni	Ta	BEPU
735	Cu+Ni	TS	B
736	Cu+Ni	SS	BDPF
737	Cu+Ni	LCS	BDPF
738	Cu+Ni	MCS	BDPF
739	Cu+Ni	HCS	BDPF
740	Cu+Ni	AS	BDP
741	Cu+Ni	CS	BDP
742	Cu+Ni	Ag	EDPU
743	Cu+Ni	Si	NW
744	Cu+Ni	Rn	E
745	Cu+Ni	Rh	E
746	Cu+Ni	Pt	EU
747	Cu+Ni	Pd	U
748	Cu+Ni	Ir	U
749	Cu+Ni	Nm	BEDPU
750	Cu+Ni	Ni+Cr+Fe	BEDPU
751	Cu+Ni	Cu+Zn+Ni	BEDPU
752	Cu+Ni	Ni	BEDPU
753	Cu+Ni	Ni+Cu	BEDPU
754	Cu+Ni	Mo	BEDU
755	Cu+Ni	Mg	U
756	Cu+Ni	Pb	NW
757	Cu+Ni	Gp	B
758	Cu+Ni	Au	DEPU
759	Cu+Ni	Gr	NW
760	Gr	Zr	NW
761	Gr	Hf	NW
762	Gr	Zn	NW
763	Gr	V	NW
764	Gr	U	NW
765	Gr	W	NW
766	Gr	Ti	NW
767	Gr	Tial	NW
768	Gr	Sn	NW
769	Gr	Cd	NW
770	Gr	Th	NW

771	Gr	Ta	NW
772	Gr	TS	NW
773	Gr	SS	NW
774	Gr	LCS	NW
775	Gr	MCS	NW
776	Gr	HCS	NW
777	Gr	AS	NW
778	Gr	CS	NW
779	Gr	Ag	NW
780	Gr	Si	NW
781	Gr	Rn	NW
782	Gr	Rh	NW
783	Gr	Pt	U
784	Gr	Pd	NW
785	Gr	Ir	NW
786	Gr	Nm	NW
787	Gr	Ni+Cr+Fe	NW
788	Gr	Cu+Zn+Ni	NW
789	Gr	Ni	NW
790	Gr	Ni+Cu	NW
791	Gr	Mo	NW
792	Gr	Mg	NW
793	Gr	Pb	NW
794	Gr	Gp	NW
795	Gr	Au	U
796	Au	Zr	U
797	Au	Hf	U
798	Au	Zn	NW
799	Au	V	NW
800	Au	U	NW
801	Au	W	EU
802	Au	Ti	U
803	Au	Tial	U
804	Au	Sn	NW
805	Au	Cd	NW
806	Au	Th	NW
807	Au	Ta	EP
808	Au	TS	NW
809	Au	SS	P
810	Au	LCS	P
811	Au	MCS	P
812	Au	HCS	P
813	Au	AS	NW
814	Au	CS	NW
815	Au	Ag	EU
816	Au	Si	U
817	Au	Rn	E
818	Au	Rh	E
819	Au	Pt	EU
820	Au	Pd	U
821	Au	Ir	U
822	Au	Nm	DEPU
823	Au	Ni+Cr+Fe	DEPU
824	Au	Cu+Zn+Ni	EPU
825	Au	Ni	DEPU
826	Au	Ni+Cu	DEPU
827	Au	Mo	EP
828	Au	Mg	NW
829	Au	Pb	NW
830	Au	Gp	NW
831	Gp	Zr	BD
832	Gp	Hf	BD
833	Gp	Zn	NW
834	Gp	V	B
835	Gp	U	NW
836	Gp	W	B
837	Gp	Ti	BD
838	Gp	Tial	BD
839	Gp	Sn	NW
840	Gp	Cd	NW
841	Gp	Th	NW
842	Gp	Ta	B

843	Gp	TS	NW
844	Gp	SS	D
845	Gp	LCS	B
846	Gp	MCS	B
847	Gp	HCS	B
848	Gp	AS	B
849	Gp	CS	B
850	Gp	Ag	NW
851	Gp	Si	NW
852	Gp	Rn	NW
853	Gp	Rh	NW
854	Gp	Pt	NW
855	Gp	Pd	NW
856	Gp	Ir	NW
857	Gp	Nm	NW
858	Gp	Ni+Cr+Fe	NW
859	Gp	Cu+Zn+Ni	NW
860	Gp	Ni	NW
861	Gp	Ni+Cu	NW
862	Gp	Mo	B
863	Gp	Mg	NW
864	Gp	Pb	NW
865	Pb	Zr	NW
866	Pb	Hf	NW
867	Pb	Zn	NW
868	Pb	V	NW
869	Pb	U	NW
870	Pb	W	NW
871	Pb	Ti	NW
872	Pb	Tial	NW
873	Pb	Sn	NW
874	Pb	Cd	NW
875	Pb	Th	NW
876	Pb	Ta	D
877	Pb	TS	NW
878	Pb	SS	NW
879	Pb	LCS	NW
880	Pb	MCS	NW
881	Pb	HCS	NW
882	Pb	AS	NW
883	Pb	CS	NW
884	Pb	Ag	NW
885	Pb	Si	NW
886	Pb	Rn	NW
887	Pb	Rh	NW
888	Pb	Pt	NW
889	Pb	Pd	NW
890	Pb	Ir	NW
891	Pb	Nm	D
892	Pb	Ni+Cr+Fe	D
893	Pb	Cu+Zn+Ni	NW
894	Pb	Ni	D
895	Pb	Ni+Cu	D
896	Pb	Mo	NW
897	Pb	Mg	NW
898	Mg	Zr	E
899	Mg	Hf	E
900	Mg	Zn	NW
901	Mg	V	NW
902	Mg	U	NW
903	Mg	W	E
904	Mg	Ti	EPU
905	Mg	Tial	EPU
906	Mg	Sn	NW
907	Mg	Cd	NW
908	Mg	Th	NW
909	Mg	Ta	E
910	Mg	TS	NW
911	Mg	SS	NW
912	Mg	LCS	P
913	Mg	MCS	P
914	Mg	HCS	P

915	Mg	AS	P
916	Mg	CS	P
917	Mg	Ag	U
918	Mg	Si	NW
919	Mg	Rn	E
920	Mg	Rh	E
921	Mg	Pt	NW
922	Mg	Pd	NW
923	Mg	Ir	NW
924	Mg	Nm	DP
925	Mg	Ni+Cr+Fe	DP
926	Mg	Cu+Zn+Ni	P
927	Mg	Ni	DP
928	Mg	Ni+Cu	DP
929	Mg	Mo	E
930	Mo	Zr	DU
931	Mo	Hf	DU
932	Mo	Zn	NW
933	Mo	V	NW
934	Mo	U	NW
935	Mo	W	DEU
936	Mo	Ti	DEU
937	Mo	Tial	DEU
938	Mo	Sn	E
939	Mo	Cd	E
940	Mo	Th	NW
941	Mo	Ta	DEU
942	Mo	TS	NW
943	Mo	SS	BD
944	Mo	LCS	BD
945	Mo	MCS	BD
946	Mo	HCS	BD
947	Mo	AS	BD
948	Mo	CS	BD
949	Mo	Ag	E
950	Mo	Si	NW
951	Mo	Rn	NW
952	Mo	Rh	NW
953	Mo	Pt	DEU
954	Mo	Pd	D
955	Mo	Ir	D
956	Mo	Nm	BDU
957	Mo	Ni+Cr+Fe	BDU
958	Mo	Cu+Zn+Ni	BU
959	Mo	Ni	BDU
960	Mo	Ni+Cu	BDU
961	Ni+Cu	Zr	BD
962	Ni+Cu	Hf	BD
963	Ni+Cu	Zn	NW
964	Ni+Cu	V	B
965	Ni+Cu	U	D
966	Ni+Cu	W	BDU
967	Ni+Cu	Tial	BDPU
968	Ni+Cu	Ti	BDPU
969	Ni+Cu	Sn	NW
970	Ni+Cu	Cd	NW
971	Ni+Cu	Th	NW
972	Ni+Cu	Ta	BPU
973	Ni+Cu	TS	B
974	Ni+Cu	SS	BDPF
975	Ni+Cu	LCS	BDPF
976	Ni+Cu	MCS	BDPF
977	Ni+Cu	HCS	BDPF
978	Ni+Cu	AS	BDPF
979	Ni+Cu	CS	BDPF
980	Ni+Cu	Ag	E
981	Ni+Cu	Si	NW
982	Ni+Cu	Rn	E
983	Ni+Cu	Rh	E
984	Ni+Cu	Pt	DEPU
985	Ni+Cu	Pd	DU
986	Ni+Cu	Ir	DU

987	Ni+Cu	Nm	BDPU
988	Ni+Cu	Ni+Cr+Fe	BDPU
989	Ni+Cu	Cu+Zn+Ni	BPU
990	Ni+Cu	Ni	BDPU
991	Ni	Zr	BD
992	Ni	Hf	BD
993	Ni	Zn	NW
994	Ni	V	B
995	Ni	U	D
996	Ni	W	BDU
997	Ni	Ti	BDPU
998	Ni	Tial	BDPU
999	Ni	Sn	NW
1000	Ni	Cd	NW
1001	Ni	Th	NW
1002	Ni	Ta	BPU
1003	Ni	TS	BF
1004	Ni	SS	BDPF
1005	Ni	LCS	BDPF
1006	Ni	MCS	BDPF
1007	Ni	HCS	BDPF
1008	Ni	AS	BDPF
1009	Ni	CS	BDPF
1010	Ni	Ag	E
1011	Ni	Si	NW
1012	Ni	Rn	E
1013	Ni	Rh	E
1014	Ni	Pt	DEPU
1015	Ni	Pd	DU
1016	Ni	Ir	DU
1017	Ni	Nm	BDPU
1018	Ni	Ni+Cr+Fe	BDPU
1019	Ni	Cu+Zn+Ni	BPU
1020	Cu+Zn+Ni	Zr	BD
1021	Cu+Zn+Ni	Hf	BD
1022	Cu+Zn+Ni	Zn	NW
1023	Cu+Zn+Ni	V	B
1024	Cu+Zn+Ni	U	D
1025	Cu+Zn+Ni	W	BDU
1026	Cu+Zn+Ni	Ti	BDPU
1027	Cu+Zn+Ni	Tial	BDPU
1028	Cu+Zn+Ni	Sn	NW
1029	Cu+Zn+Ni	Cd	NW
1030	Cu+Zn+Ni	Th	NW
1031	Cu+Zn+Ni	Ta	BPU
1032	Cu+Zn+Ni	TS	BF
1033	Cu+Zn+Ni	SS	BDPF
1034	Cu+Zn+Ni	LCS	BDPF
1035	Cu+Zn+Ni	MCS	BDPF
1036	Cu+Zn+Ni	HCS	BDPF
1037	Cu+Zn+Ni	AS	BDPF
1038	Cu+Zn+Ni	CS	BDPF
1039	Cu+Zn+Ni	Ag	E
1040	Cu+Zn+Ni	Si	NW
1041	Cu+Zn+Ni	Rn	E
1042	Cu+Zn+Ni	Rh	E
1043	Cu+Zn+Ni	Pt	DEPU
1044	Cu+Zn+Ni	Pd	DU
1045	Cu+Zn+Ni	Ir	DU
1046	Cu+Zn+Ni	Nm	BPU
1047	Cu+Zn+Ni	Ni+Cr+Fe	BPFUSL
1048	Ni+Cr+Fe	Zr	BD
1049	Ni+Cr+Fe	Hf	BD
1050	Ni+Cr+Fe	Zn	NW
1051	Ni+Cr+Fe	V	B
1052	Ni+Cr+Fe	U	D
1053	Ni+Cr+Fe	W	BDU
1054	Ni+Cr+Fe	Ti	BDPU
1055	Ni+Cr+Fe	Tial	BDPU
1056	Ni+Cr+Fe	Sn	NW
1057	Ni+Cr+Fe	Cd	NW
1058	Ni+Cr+Fe	Th	NW

1059	Ni+Cr+Fe	Ta	BPU
1060	Ni+Cr+Fe	TS	BF
1061	Ni+Cr+Fe	SS	BDPF
1062	Ni+Cr+Fe	LCS	BDPF
1063	Ni+Cr+Fe	MCS	BDPF
1064	Ni+Cr+Fe	HCS	BDPF
1065	Ni+Cr+Fe	AS	BDPF
1066	Ni+Cr+Fe	CS	BDPF
1067	Ni+Cr+Fe	Ag	E
1068	Ni+Cr+Fe	Si	NW
1069	Ni+Cr+Fe	Rn	E
1070	Ni+Cr+Fe	Rh	E
1071	Ni+Cr+Fe	Pt	DEPU
1072	Ni+Cr+Fe	Pd	DU
1073	Ni+Cr+Fe	Ir	DU
1074	Ni+Cr+Fe	Nm	BDPU
1075	Nm	Zr	BD
1076	Nm	Hf	BD
1077	Nm	Zn	NW
1078	Nm	V	B
1079	Nm	U	D
1080	Nm	W	BDU
1081	Nm	Ti	BDPU
1082	Nm	Tial	BDPU
1083	Nm	Sn	NW
1084	Nm	Cd	NW
1085	Nm	Th	NW
1086	Nm	Ta	BPU
1087	Nm	TS	BF
1088	Nm	SS	BDPF
1089	Nm	LCS	BDPF
1090	Nm	MCS	BDPF
1091	Nm	HCS	BDPF
1092	Nm	AS	BDPF
1093	Nm	CS	BDPF
1094	Nm	Ag	E
1095	Nm	Si	NW
1096	Nm	Rn	E
1097	Nm	Rh	E
1098	Nm	Pt	DEPU
1099	Nm	Pd	DU
1100	Nm	Ir	DU
1101	Ir	Zr	NW
1102	Ir	Hf	NW
1103	Ir	Zn	NW
1104	Ir	V	NW
1105	Ir	U	NW
1106	Ir	W	D
1107	Ir	Ti	NW
1108	Ir	Tial	NW
1109	Ir	Sn	NW
1110	Ir	Cd	NW
1111	Ir	Th	NW
1112	Ir	Ta	U
1113	Ir	TS	NW
1114	Ir	SS	D
1115	Ir	LCS	D
1116	Ir	MCS	D
1117	Ir	HCS	D
1118	Ir	AS	D
1119	Ir	CS	D
1120	Ir	Ag	U
1121	Ir	Si	NW
1122	Ir	Rn	NW
1123	Ir	Rh	NW
1124	Ir	Pt	NW
1125	Ir	Pd	DUSL
1126	Pd	Zr	NW
1127	Pd	Hf	NW
1128	Pd	Zn	NW
1129	Pd	V	NW
1130	Pd	U	NW

1131	Pd	W	D
1132	Pd	Tial	NW
1133	Pd	Ti	NW
1134	Pd	Sn	NW
1135	Pd	Cd	NW
1136	Pd	Th	NW
1137	Pd	Ta	U
1138	Pd	TS	NW
1139	Pd	SS	D
1140	Pd	LCS	D
1141	Pd	MCS	D
1142	Pd	HCS	D
1143	Pd	AS	D
1144	Pd	CS	D
1145	Pd	Ag	U
1146	Pd	Si	NW
1147	Pd	Rn	NW
1148	Pd	Rh	NW
1149	Pd	Pt	NW
1150	Pt	Zr	NW
1151	Pt	Hf	NW
1152	Pt	Zn	NW
1153	Pt	V	NW
1154	Pt	U	NW
1155	Pt	W	DEU
1156	Pt	Ti	U
1157	Pt	Tial	U
1158	Pt	Sn	NW
1159	Pt	Cd	NW
1160	Pt	Th	NW
1161	Pt	Ta	U
1162	Pt	TS	NW
1163	Pt	SS	NW
1164	Pt	LCS	NW
1165	Pt	MCS	NW
1166	Pt	HCS	NW
1167	Pt	AS	NW
1168	Pt	CS	NW
1169	Pt	Ag	E
1170	Pt	Si	U
1171	Pt	Rn	E
1172	Pt	Rh	E
1173	Rh	Zr	NW
1174	Rh	Hf	NW
1175	Rh	Zn	NW
1176	Rh	V	NW
1177	Rh	U	NW
1178	Rh	W	NW
1179	Rh	Tial	NW
1180	Rh	Ti	NW
1181	Rh	Sn	E
1182	Rh	Cd	E
1183	Rh	Th	NW
1184	Rh	Ta	NW
1185	Rh	TS	NW
1186	Rh	SS	NW
1187	Rh	LCS	NW
1188	Rh	MCS	NW
1189	Rh	HCS	NW
1190	Rh	AS	NW
1191	Rh	CS	NW
1192	Rh	Ag	E
1193	Rh	Si	NW
1194	Rh	Rn	NW
1195	Rn	Hf	NW
1196	Rn	Zn	NW
1197	Rn	V	NW
1198	Rn	U	NW
1199	Rn	W	NW
1200	Rn	Ti	NW
1201	Rn	Tial	NW
1202	Rn	Zr	NW

1203	Rn	Sn	E
1204	Rn	Cd	E
1205	Rn	Th	NW
1206	Rn	Ta	NW
1207	Rn	TS	NW
1208	Rn	SS	NW
1209	Rn	LCS	NW
1210	Rn	MCS	NW
1211	Rn	HCS	NW
1212	Rn	AS	NW
1213	Rn	CS	NW
1214	Rn	Ag	E
1215	Rn	Si	NW
1216	Si	Zr	NW
1217	Si	Hf	NW
1218	Si	Zn	NW
1219	Si	V	NW
1220	Si	U	NW
1221	Si	W	NW
1222	Si	Ti	NW
1223	Si	Tial	NW
1224	Si	Sn	NW
1225	Si	Cd	NW
1226	Si	Th	NW
1227	Si	Ta	U
1228	Si	TS	NW
1229	Si	SS	NW
1230	Si	LCS	NW
1231	Si	MCS	NW
1232	Si	HCS	NW
1233	Si	AS	NW
1234	Si	CS	NW
1235	Si	Ag	U
1236	Ag	Zr	DU
1237	Ag	Hf	DU
1238	Ag	Zn	NW
1239	Ag	V	NW
1240	Ag	U	NW
1241	Ag	W	E
1242	Ag	Tial	DEP
1243	Ag	Ti	DEP
1244	Ag	Sn	E
1245	Ag	Cd	E
1246	Ag	Th	NW
1247	Ag	Ta	U
1248	Ag	TS	NW
1249	Ag	SS	DP
1250	Ag	LCS	P
1251	Ag	MCS	P
1252	Ag	HCS	P
1253	Ag	AS	NW
1254	Ag	CS	NW
1255	CS	Zr	BDP
1256	CS	Hf	BDP
1257	CS	Zn	NW
1258	CS	V	B
1259	CS	U	NW
1260	CS	W	BD
1261	CS	Ti	BDP
1262	CS	Tial	BDP
1263	CS	Sn	NW
1264	CS	Cd	NW
1265	CS	Th	NW
1266	CS	Ta	BP
1267	CS	TS	BF
1268	CS	SS	BFP
1269	CS	LCS	BDPF
1270	CS	MCS	BDPF
1271	CS	HCS	BDPF
1272	CS	AS	BDPF
1273	AS	Zr	BDP
1274	AS	Hf	BDP

1275	AS	Zn	NW
1276	AS	V	B
1277	AS	U	NW
1278	AS	W	BD
1279	AS	Ti	BDP
1280	AS	Tial	BDP
1281	AS	Sn	NW
1282	AS	Cd	NW
1283	AS	Th	NW
1284	AS	Ta	BP
1285	AS	TS	BF
1286	AS	SS	BFP
1287	AS	LCS	BDPF
1288	AS	MCS	BDPF
1289	AS	HCS	BDPF
1290	HCS	Zr	BDP
1291	HCS	Hf	BDP
1292	HCS	Zn	NW
1293	HCS	V	B
1294	HCS	U	NW
1295	HCS	W	BD
1296	HCS	Ti	BDP
1297	HCS	Tial	BDP
1298	HCS	Sn	NW
1299	HCS	Cd	NW
1300	HCS	Th	NW
1301	HCS	Ta	BP
1302	HCS	TS	BF
1303	HCS	SS	BPF
1304	HCS	LCS	BDPFSL
1305	HCS	MCS	BDPFSL
1306	MCS	Zr	BDP
1307	MCS	Hf	BDP
1308	MCS	Zn	NW
1309	MCS	V	B
1310	MCS	U	NW
1311	MCS	W	BD
1312	MCS	Ti	BDP
1313	MCS	Tial	BDP
1314	MCS	Sn	NW
1315	MCS	Cd	NW
1316	MCS	Th	NW
1317	MCS	Ta	BP
1318	MCS	TS	BF
1319	MCS	SS	BPF
1320	MCS	LCS	BDPFSL
1321	LCS	Zr	BDP
1322	LCS	Hf	BDP
1323	LCS	Zn	NW
1324	LCS	V	B
1325	LCS	U	NW
1326	LCS	W	BD
1327	LCS	Ti	BDP
1328	LCS	Tial	BDP
1329	LCS	Sn	NW
1330	LCS	Cd	NW
1331	LCS	Th	NW
1332	LCS	Ta	BP
1333	LCS	TS	BF
1334	LCS	SS	BPF
1335	SS	Zr	BDF
1336	SS	Hf	BDF
1337	SS	Zn	NW
1338	SS	V	B
1339	SS	U	NW
1340	SS	W	B
1341	SS	Ti	BDPF
1342	SS	Tial	BDPF
1343	SS	Sn	NW
1344	SS	Cd	NW
1345	SS	Th	NW
1346	SS	Ta	BP

1347	BS	TS	B
1348	TS	Zr	NW
1349	TS	Hf	NW
1350	TS	Zn	NW
1351	TS	V	NW
1352	TS	U	NW
1353	TS	W	NW
1354	TS	Ti	NW
1355	TS	Tial	NW
1356	TS	Sn	NW
1357	TS	Cd	NW
1358	TS	Th	NW
1359	TS	Ta	NW
1360	Ta	Zr	DE
1361	Ta	Hf	DE
1362	Ta	Zn	NW
1363	Ta	V	D
1364	Ta	U	NW
1365	Ta	W	EU
1366	Ta	Ti	DEPU
1367	Ta	Tial	DEPFU
1368	Ta	Sn	NW
1369	Ta	Cd	NW
1370	Ta	Th	NW
1371	Th	Zr	NW
1372	Th	Hf	NW
1373	Th	Zn	NW
1374	Th	V	NW
1375	Th	U	NW
1376	Th	W	NW
1377	Th	Ti	NW
1378	Th	Tial	NW
1379	Th	Sn	NW
1380	Th	Cd	NW
1381	Sn	Zr	NW
1382	Sn	Hf	NW
1383	Sn	Zn	NW
1384	Sn	V	NW
1385	Sn	U	NW
1386	Sn	W	E
1387	Sn	Ti	NW
1388	Sn	Tial	NW
1389	Sn	Cd	US
1390	Cd	Zr	NW
1391	Cd	Hf	NW
1392	Cd	Zn	NW
1393	Cd	V	NW
1394	Cd	U	NW
1395	Cd	W	E
1396	Cd	Ti	NW
1397	Cd	Tial	NW
1398	Ti	Zr	BEP
1399	Ti	Hf	BEP
1400	Ti	Zn	NW
1401	Ti	V	B
1402	Ti	U	D
1403	Ti	W	EU
1404	Ti	Tial	B
1405	Tial	Zr	BEP
1406	Tial	Hf	BEP
1407	Tial	Zn	NW
1408	Tial	V	B
1409	Tial	U	D
1410	Tial	W	E
1411	W	Zr	NW
1412	W	Hf	NW
1413	W	Zn	NW
1414	W	V	NW
1415	W	U	NW
1416	U	Zr	D
1417	U	Hf	D
1418	U	Zn	NW

1420	V	Zr	NW
1421	V	Hf	NW
1422	V	Zn	NW
1423	Zn	Zr	NW
1424	Zn	Hf	NW
1425	Hf	Zr	DPFUL

COMSHAPE.DBF (Procedure code based on combination of shapes with an orientation)

Fields name → / Records ↓	Ist_shape (Shap_code1)	IInd_shape (Shap_code2)	Orientation (Orien_Code)	Procedure (Proc_Code)
1	1	1	1	1
2	1	1	2	13
3	1	1	3	2
4	1	1	4	14
5	1	1	5	3
6	1	1	6	4
7	1	2	1	5
8	1	2	2	15
9	1	2	3	6
10	1	2	4	16
11	1	2	5	3
12	1	2	6	4
13	1	3	1	5
14	1	3	2	15
15	1	3	3	6
16	1	3	4	16
17	1	3	5	3
18	1	3	6	4
19	1	4	1	7
20	1	4	2	17
21	1	4	3	8
22	1	4	4	18
23	1	4	5	29
24	1	4	6	4
25	2	2	1	11
26	2	2	2	15
27	2	2	3	27
28	2	2	4	21
29	2	2	5	22
30	2	2	6	25
31	2	3	1	11
32	2	3	2	15
33	2	3	3	27
34	2	3	4	21
35	2	3	5	22
36	2	3	6	25
37	2	4	1	12
38	2	4	2	17
39	2	4	3	26
40	2	4	4	23
41	2	4	5	24
42	2	4	6	25
43	3	3	1	11
44	3	3	2	15
45	3	3	3	27
46	3	3	4	21
47	3	3	5	22
48	3	3	6	25
49	3	4	1	12
50	3	4	2	17
51	3	4	3	26
52	3	4	4	23
53	3	4	5	24
54	3	4	6	25
55	4	4	1	9
56	4	4	2	19
57	4	4	3	10
			4	20
			5	28

PROSHAP.DBF (Processes based on shapes combination with a joint type)

Fields name → / Records ↓	Inj_shape (Shap_Code1)	Ejec_shape (Shap_Code2)	Joint (Joint_Code)	Cas Cas	Spo Spo	Rou Rou	FCAW	Mig Mig	Pmr Pmr	Lmr Lmr	Smaw Smaw	Tig Tig	Brazing Brazing	Mfr Mfr	Ehr Ehr	Lmr Lmr	Fro Fro	Lfr Lfr	Soldering Soldering	Ssw Ssw
1	1	1	1	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
2	1	1	2	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
3	1	1	3	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
4	1	1	4	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y
5	1	2	2	Y	N	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y	N
6	1	2	3	Y	N	N	N	Y	Y	N	Y	Y	Y	N	Y	Y	N	Y	Y	N
7	1	2	4	N	N	N	N	N	N	N	N	N	Y	N	Y	Y	N	Y	Y	N
8	1	3	3	Y	N	N	N	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
9	1	3	4	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	N
10	1	4	4	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	N
11	2	1	1	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
12	2	1	2	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
13	2	1	3	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
14	2	1	4	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
15	2	2	2	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
16	2	2	3	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
17	2	2	4	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
18	2	3	3	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
19	2	3	4	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
20	2	4	4	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
21	3	5	5	Y	N	N	N	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
22																				

PROTHICK.DBF (Working thickness range for processes)

Fields name → / Records ↓	Process (Process)	Material (Matl_name)	WT_lower (Lower_lim)	WT_upper (Upper_lim)
1	CAW	LCS	0.05000	0.25000
2	CAW	MCS	0.05000	0.25000
3	CAW	HCS	0.05000	0.25000
4	CAW	TS	0.05000	0.25000
5	CAW	CS	0.05000	0.25000
6	CAW	AS	0.05000	0.25000
7	CAW	GCI	0.12500	0.75000
8	CAW	MCI	0.12500	0.75000
9	CAW	SS	0.00000	0.00000
10	CAW	Al	0.00000	0.00000
11	CAW	Alal	0.00000	0.00000
12	CAW	Cu	0.06250	0.75000
13	CAW	Cu+Zn	0.10000	0.25000
14	CAW	Cu+Sn	0.06250	0.75000
15	CAW	Cu+Al	0.06250	0.75000
16	CAW	Cu+Si	0.06250	0.75000
17	CAW	Cu+Zn+Ni	0.06250	0.75000
18	CAW	Cu+Ni	0.06250	0.75000
19	CAW	Pb	0.00000	0.00000
20	CAW	Sn	0.00000	0.00000
21	CAW	Cd	0.00000	0.00000
22	CAW	Mg	0.00000	0.00000
23	CAW	Mo	0.00050	0.12500
24	CAW	Ni	0.03700	0.07000
25	CAW	Ni+Cu	0.03700	0.07000
26	CAW	Ni+Cr+Fe	0.03700	0.07000
27	CAW	Zn	0.00000	0.00000
28	CAW	Au	0.00000	0.00000
29	CAW	Ag	0.00000	0.00000
30	CAW	Be	0.00000	0.00000
31	CAW	Cc	0.00000	0.00000
32	CAW	Cm	0.00000	0.00000
33	CAW	Cr	0.00000	0.00000
34	CAW	Co	0.00000	0.00000
35	CAW	Gr	0.00000	0.00000
36	CAW	Gp	0.00000	0.00000
37	CAW	Hf	0.00000	0.00000
38	CAW	Ir	0.00000	0.00000
39	CAW	Nm	0.00000	0.00000
40	CAW	Nb OR Cb	0.00000	0.00000
41	CAW	Pd	0.00000	0.00000
42	CAW	Pt	0.00000	0.00000
43	CAW	Rn	0.00000	0.00000
44	CAW	Rh	0.00000	0.00000
45	CAW	Si	0.00050	0.12500
46	CAW	Ta	0.00000	0.00000
47	CAW	Th	0.00000	0.00000
48	CAW	Ti	0.00000	0.00000
49	CAW	Tial	0.00000	0.00000
50	CAW	W	0.00000	0.00000
51	CAW	WC	0.00000	0.00000
52	CAW	U	0.00000	0.00000
53	CAW	V	0.00000	0.00000
54	CAW	Zr	0.00000	0.00000
55	EGW	Al	0.00000	0.00000
56	EGW	Alal	0.00000	0.00000
57	EGW	Be	0.00000	0.00000
58	EGW	Cu+Zn	0.00000	0.00000
59	EGW	Cu+Sn	0.25000	100.00000
60	EGW	CS	0.00000	0.00000
61	EGW	Cc	0.00000	0.00000
62	EGW	Cm	0.00000	0.00000
63	EGW	Cr	0.00000	0.00000
64	EGW	Co	0.00000	0.00000
65	EGW	Cu	0.00000	0.00000
66	EGW	Cu+Ni	0.00000	0.00000
67	EGW	Gr		

68	EGW	Au	0.00000	0.00000
69	EGW	Gp	0.00000	0.00000
70	EGW	GCI	0.00000	0.00000
71	EGW	Hf	0.00000	0.00000
72	EGW	HCS	0.00000	0.00000
73	EGW	Ni+Cr+Fe	0.25000	100.00000
74	EGW	Ir	0.00000	0.00000
75	EGW	Pb	0.00000	0.00000
76	EGW	Sn	0.00000	0.00000
77	EGW	Cd	0.00000	0.00000
78	EGW	Zn	0.00000	0.00000
79	EGW	AS	0.25000	100.00000
80	EGW	LCS	0.25000	100.00000
81	EGW	Mg	0.00000	0.00000
82	EGW	MCI	0.00000	0.00000
83	EGW	MCS	0.25000	100.00000
84	EGW	Mo	0.00000	0.00000
85	EGW	Ni+Cu	0.25000	100.00000
86	EGW	Ni	0.25000	100.00000
87	EGW	Cu+Zn+Ni	0.00000	0.00000
88	EGW	Nm	0.25000	100.00000
89	EGW	Nb OR Cb	0.00000	0.00000
90	EGW	Pd	0.00000	0.00000
91	EGW	Pt	0.00000	0.00000
92	EGW	Rn	0.00000	0.00000
93	EGW	Rh	0.00000	0.00000
94	EGW	Si	0.00000	0.00000
95	EGW	Cu+Si	0.00000	0.00000
96	EGW	Ag	0.00000	0.00000
97	EGW	SS	0.25000	100.00000
98	EGW	Ta	0.00000	0.00000
99	EGW	Th	0.00000	0.00000
100	EGW	Ti	0.00000	0.00000
101	EGW	Tial	0.00000	0.00000
102	EGW	TS	0.25000	100.00000
103	EGW	W	0.00000	0.00000
104	EGW	WC	0.00000	0.00000
105	EGW	U	0.00000	0.00000
106	EGW	V	0.00000	0.00000
107	EGW	Zr	0.00000	0.00000
108	EGW	Cu+Al	0.00000	0.00000
109	FCAW	Al	0.00000	0.00000
110	FCAW	Alal	0.00000	0.00000
111	FCAW	Cu+Al	0.00000	0.00000
112	FCAW	Be	0.00000	0.00000
113	FCAW	Cu+Zn	0.00000	0.00000
114	FCAW	Cu+Sn	0.00000	0.00000
115	FCAW	CS	0.12500	100.00000
116	FCAW	Cc	0.00000	0.00000
117	FCAW	Cm	0.00000	0.00000
118	FCAW	Cr	0.00000	0.00000
119	FCAW	Co	0.00000	0.00000
120	FCAW	Cu	0.00000	0.00000
121	FCAW	Cu+Ni	0.00000	0.00000
122	FCAW	Gr	0.00000	0.00000
123	FCAW	Au	0.00000	0.00000
124	FCAW	Gp	0.00000	0.00000
125	FCAW	GCI	0.12500	0.75000
126	FCAW	Hf	0.00000	0.00000
127	FCAW	HCS	0.12500	100.00000
128	FCAW	Ni+Cr+Fe	0.06250	0.75000
129	FCAW	Ir	0.00000	0.00000
130	FCAW	Pb	0.00000	0.00000
131	FCAW	Sn	0.00000	0.00000
132	FCAW	Cd	0.00000	0.00000
133	FCAW	Zn	0.00000	0.00000
134	FCAW	AS	0.12500	100.00000
135	FCAW	LCS	0.12500	100.00000
136	FCAW	Mg	0.00000	0.00000
137	FCAW	MCI	0.12500	0.75000
138	FCAW	MCS	0.12500	100.00000

139	FCAW	Mo	0.00000	0.00000
140	FCAW	Ni+Cu	0.06250	0.75000
141	FCAW	Ni	0.06250	0.75000
142	FCAW	Cu+Zn+Ni	0.00000	0.00000
143	FCAW	Mn	0.06250	0.75000
144	FCAW	Nb OR Cb	0.00000	0.00000
145	FCAW	Pd	0.6120	0.6150
146	FCAW	Pt	0.00000	0.00000
147	FCAW	Rn	0.00000	0.00000
148	FCAW	Rh	0.00000	0.00000
149	FCAW	Si	0.00000	0.00000
150	FCAW	Cu+Si	0.00000	0.00000
151	FCAW	Ag	0.00000	0.00000
152	FCAW	SS	0.12500	100.00000
153	FCAW	Ta	0.00000	0.00000
154	FCAW	Th	0.00000	0.00000
155	FCAW	Ti	0.06250	0.75000
156	FCAW	Tial	0.06250	0.75000
157	FCAW	TS	0.12500	100.00000
158	FCAW	W	0.00000	0.00000
159	FCAW	WC	0.00000	0.00000
160	FCAW	U	0.00000	0.00000
161	FCAW	V	0.00000	0.00000
162	FCAW	Zr	0.00000	0.00000
163	MIG_SPRAY	Al	0.20000	0.75000
164	MIG_SPRAY	Alal	0.20000	0.75000
165	MIG_SPRAY	Cu+Al	0.20000	0.75000
166	MIG_SPRAY	Be	0.20000	0.75000
167	MIG_SPRAY	Cu+Zn	0.20000	0.75000
168	MIG_SPRAY	Cu+Sn	0.20000	0.75000
169	MIG_SPRAY	CS	0.12500	100.00000
170	MIG_SPRAY	Cc	0.20000	0.75000
171	MIG_SPRAY	Cm	0.20000	0.75000
172	MIG_SPRAY	Cr	0.00000	0.00000
173	MIG_SPRAY	Co	0.20000	0.75000
174	MIG_SPRAY	Cu	0.20000	0.75000
175	MIG_SPRAY	Cu+Ni	0.20000	0.75000
176	MIG_SPRAY	Gr	0.00000	0.00000
177	MIG_SPRAY	Au	0.20000	0.75000
178	MIG_SPRAY	Gp	0.00000	0.00000
179	MIG_SPRAY	GCI	0.12500	100.00000
180	MIG_SPRAY	Hf	0.20000	0.75000
181	MIG_SPRAY	HCS	0.12500	100.00000
182	MIG_SPRAY	Ni+Cr+Fe	0.00000	100.00000
183	MIG_SPRAY	Ir	0.20000	0.75000
184	MIG_SPRAY	Pb	0.00000	0.00000
185	MIG_SPRAY	Sn	0.00000	0.00000
186	MIG_SPRAY	Cd	0.00000	0.00000
187	MIG_SPRAY	Zn	0.00000	0.00000
188	MIG_SPRAY	AS	0.12500	100.00000
189	MIG_SPRAY	LCS	0.12500	100.00000
190	MIG_SPRAY	Mg	0.20000	0.75000
191	MIG_SPRAY	MCI	0.12500	100.00000
192	MIG_SPRAY	MCS	0.12500	100.00000
193	MIG_SPRAY	Mo	0.12500	0.25000
194	MIG_SPRAY	Ni+Cu	0.00000	100.00000
195	MIG_SPRAY	Ni	0.00000	100.00000
196	MIG_SPRAY	Cu+Zn+Ni	0.20000	0.75000
197	MIG_SPRAY	Mn	0.00000	100.00000

198	MIG_SPRAY	Nb OR Cb	0.20000	0.75000
199	MIG_SPRAY	Pd	0.20000	0.75000
200	MIG_SPRAY	Pt	0.20000	0.75000
201	MIG_SPRAY	Rn	0.20000	0.75000
202	MIG_SPRAY	Rh	0.20000	0.75000
203	MIG_SPRAY	Si	0.20000	0.75000
204	MIG_SPRAY	Cu+Si	0.20000	0.75000
205	MIG_SPRAY	Ag	0.20000	0.75000
206	MIG_SPRAY	SS	0.12500	100.00000
207	MIG_SPRAY	Ta	0.12500	0.25000
208	MIG_SPRAY	Th	0.00000	0.00000
209	MIG_SPRAY	Ti	0.20000	0.75000
210	MIG_SPRAY	Tial	0.20000	0.75000
211	MIG_SPRAY	TS	0.12500	100.00000
212	MIG_SPRAY	W	0.12500	0.25000
213	MIG_SPRAY	WC	0.00000	0.00000
214	MIG_SPRAY	U	0.00000	0.00000
215	MIG_SPRAY	V	0.00000	0.00000
216	MIG_SPRAY	Zr	0.20000	0.75000
217	MIG_PULSED	Al	0.06000	0.25000
218	MIG_PULSED	Alal	0.06000	0.25000
219	MIG_PULSED	Cu+Al	0.06000	0.25000
220	MIG_PULSED	Be	0.06000	100.00000
221	MIG_PULSED	Cu+Zn	0.06000	0.25000
222	MIG_PULSED	Cu+Sn	0.06000	0.25000
223	MIG_PULSED	CS	0.06000	100.00000
224	MIG_PULSED	Cc	0.00000	0.00000
225	MIG_PULSED	Cm	0.00000	0.00000
226	MIG_PULSED	Cr	0.00000	0.00000
227	MIG_PULSED	Co	0.00000	0.00000
228	MIG_PULSED	Cu	0.06000	0.25000
229	MIG_PULSED	Cu+Ni	0.06000	0.25000
230	MIG_PULSED	Gr	0.00000	0.00000
231	MIG_PULSED	Au	0.00000	0.00000
232	MIG_PULSED	Gp	0.00000	0.00000
233	MIG_PULSED	GCI	0.12500	100.00000
234	MIG_PULSED	Hf	0.06000	100.00000
235	MIG_PULSED	HCS	0.06000	100.00000
236	MIG_PULSED	Ni+Cr+Fe	0.06000	100.00000
237	MIG_PULSED	Ir	0.00000	0.00000
238	MIG_PULSED	Pb	0.00000	0.00000
239	MIG_PULSED	Sn	0.00000	0.00000
240	MIG_PULSED	Cd	0.00000	0.00000
241	MIG_PULSED	Zn	0.00000	0.00000
242	MIG_PULSED	AS	0.06000	100.00000
243	MIG_PULSED	LCS	0.06000	100.00000
244	MIG_PULSED	Mg	0.06000	100.00000
245	MIG_PULSED	MCI	0.12500	100.00000
246	MIG_PULSED	MCS	0.06000	100.00000
247	MIG_PULSED	Mo	0.12500	0.75000
248	MIG_PULSED	Ni+Cu	0.06000	100.00000
249	MIG_PULSED	Ni	0.06000	100.00000
250	MIG_PULSED	Cu+Zn+Ni	0.06000	0.25000
251	MIG_PULSED	Nm	0.06000	100.00000
252	MIG_PULSED	Nb OR Cb	0.12500	0.75000
253	MIG_PULSED	Pd	0.00000	0.00000
254	MIG_PULSED	Pt	0.06000	0.75000
255	MIG_PULSED	Rn	0.00000	0.00000
256	MIG_PULSED	Rh	0.00000	0.00000
257	MIG_PULSED	Si	0.00000	0.00000
258	MIG_PULSED	Cu+Si	0.06000	0.25000
259	MIG_PULSED	Ag	0.06000	0.75000
260	MIG_PULSED	SS	0.06000	100.00000
261	MIG_PULSED	Ta	0.12500	0.75000
262	MIG_PULSED	Th	0.00000	0.00000
263	MIG_PULSED	Ti	0.06000	100.00000
264	MIG_PULSED	Tial	0.06000	100.00000
265	MIG_PULSED	TS	0.06000	100.00000
266	MIG_PULSED	W	0.12500	0.75000
267	MIG_PULSED	WC	0.00000	0.00000
268	MIG_PULSED	U	0.00000	0.00000
269	MIG_PULSED	V	0.00000	0.00000

270	MIG_PULSED	Zr	0.06000	100.00000
271	MIG_SHORT-DIP	Al	0.00000	0.00000
272	MIG_SHORT-DIP	Alal	0.00000	0.00000
273	MIG_SHORT-DIP	Cu+Al	0.00000	0.00000
274	MIG_SHORT-DIP	Be	0.00000	0.00000
275	MIG_SHORT-DIP	Cu+Zn	0.00000	0.00000
276	MIG_SHORT-DIP	Cu+Sn	0.00000	0.00000
277	MIG_SHORT-DIP	CS	0.08000	0.25000
278	MIG_SHORT-DIP	Cc	0.00000	0.00000
279	MIG_SHORT-DIP	Cm	0.00000	0.00000
280	MIG_SHORT-DIP	Cr	0.00000	0.00000
281	MIG_SHORT-DIP	Co	0.00000	0.00000
282	MIG_SHORT-DIP	Cu	0.00000	0.00000
283	MIG_SHORT-DIP	Cu+Ni	0.00000	0.00000
284	MIG_SHORT-DIP	Gr	0.00000	0.00000
285	MIG_SHORT-DIP	Au	0.00000	0.00000
286	MIG_SHORT-DIP	Gp	0.00000	0.00000
287	MIG_SHORT-DIP	GCI	0.00000	0.00000
288	MIG_SHORT-DIP	Hf	0.00000	0.00000
289	MIG_SHORT-DIP	HCS	0.08000	0.25000
290	MIG_SHORT-DIP	Ni+Cr+Fe	0.08000	0.25000
291	MIG_SHORT-DIP	Ir	0.00000	0.00000
292	MIG_SHORT-DIP	Pb	0.00000	0.00000
293	MIG_SHORT-DIP	Sn	0.00000	0.00000
294	MIG_SHORT-DIP	Cd	0.00000	0.00000
295	MIG_SHORT-DIP	Zn	0.00000	0.00000
296	MIG_SHORT-DIP	AS	0.08000	0.25000
297	MIG_SHORT-DIP	LCS	0.08000	0.25000
298	MIG_SHORT-DIP	Mg	0.00000	0.00000
299	MIG_SHORT-DIP	MCI	0.00000	0.00000
300	MIG_SHORT-DIP	MCS	0.08000	0.25000
301	MIG_SHORT-DIP	Mo	0.00000	0.00000
302	MIG_SHORT-DIP	Ni+Cu	0.08000	0.25000
303	MIG_SHORT-DIP	Ni	0.08000	0.25000
304	MIG_SHORT-DIP	Cu+Zn+Ni	0.00000	0.00000
305	MIG_SHORT-DIP	Nm	0.08000	0.25000
306	MIG_SHORT-DIP	Nb OR Cb	0.00000	0.00000
307	MIG_SHORT-DIP	Pd	0.00000	0.00000
308	MIG_SHORT-DIP	Pt	0.00000	0.00000
309	MIG_SHORT-DIP	Rn	0.00000	0.00000
310	MIG_SHORT-DIP	Rh	0.00000	0.00000
311	MIG_SHORT-DIP	Si	0.00000	0.00000
312	MIG_SHORT-DIP	Cu+Si	0.00000	0.00000
313	MIG_SHORT-DIP	Ag	0.00000	0.00000
314	MIG_SHORT-DIP	SS	0.08000	0.25000
315	MIG_SHORT-DIP	Ta	0.00000	0.00000
316	MIG_SHORT-DIP	Th	0.00000	0.00000
317	MIG_SHORT-DIP	Ti	0.00000	0.00000
318	MIG_SHORT-DIP	Tial	0.00000	0.00000
319	MIG_SHORT-DIP	TS	0.08000	0.25000
320	MIG_SHORT-DIP	W	0.00000	0.00000
321	MIG_SHORT-DIP	WC	0.00000	0.00000
322	MIG_SHORT-DIP	U	0.00000	0.00000
323	MIG_SHORT-DIP	V	0.00000	0.00000
324	MIG_SHORT-DIP	Zr	0.00000	0.00000
325	TIG_SPRAY	Al	0.05000	0.75000
326	TIG_SPRAY	Alal	0.05000	0.75000
327	TIG_SPRAY	Cu+Al	0.05000	0.12500
328	TIG_SPRAY	Be	0.05000	0.75000
329	TIG_SPRAY	Cu+Zn	0.05000	0.12500
330	TIG_SPRAY	Cu+Sn	0.05000	0.12500
331	TIG_SPRAY	CS	0.05000	0.25000
332	TIG_SPRAY	Cc	0.00000	0.00000
333	TIG_SPRAY	Cm	0.00000	0.00000
334	TIG_SPRAY	Cr	0.05000	0.25000
335	TIG_SPRAY	Co	0.00000	0.00000
336	TIG_SPRAY	Cu	0.05000	0.12500
337	TIG_SPRAY	Cu+Ni	0.05000	0.12500
338	TIG_SPRAY	Gr	0.00000	0.00000
339	TIG_SPRAY	Au	0.05000	0.75000
340	TIG_SPRAY	Gp	0.00000	0.00000
341	TIG_SPRAY	GCI	0.05000	0.25000

342	TIG_SPRAY	Hf	0.05000	0.75000
343	TIG_SPRAY	HCS	0.05000	0.25000
344	TIG_SPRAY	Ni+Cr+Fe	0.05000	0.25000
345	TIG_SPRAY	Ir	0.00000	0.00000
346	TIG_SPRAY	Pb	0.00000	0.00000
347	TIG_SPRAY	Sn	0.00000	0.00000
348	TIG_SPRAY	Cd	0.00000	0.00000
349	TIG_SPRAY	Zn	0.00000	0.00000
350	TIG_SPRAY	AS	0.05000	0.25000
351	TIG_SPRAY	LCS	0.05000	0.25000
352	TIG_SPRAY	Mg	0.05000	0.25000
353	TIG_SPRAY	MCI	0.05000	0.25000
354	TIG_SPRAY	MCS	0.05000	0.25000
355	TIG_SPRAY	Mo	0.05000	0.12500
356	TIG_SPRAY	Ni+Cu	0.05000	0.25000
357	TIG_SPRAY	Ni	0.05000	0.25000
358	TIG_SPRAY	Cu+Zn+Ni	0.05000	0.12500
359	TIG_SPRAY	Nm	0.05000	0.25000
360	TIG_SPRAY	Nb OR Cb	0.05000	0.12500
361	TIG_SPRAY	Pd	0.00000	0.00000
362	TIG_SPRAY	Pt	0.05000	0.75000
363	TIG_SPRAY	Rn	0.05000	0.75000
364	TIG_SPRAY	Rh	0.05000	0.75000
365	TIG_SPRAY	Si	0.00000	0.00000
366	TIG_SPRAY	Cu+Si	0.05000	0.12500
367	TIG_SPRAY	Ag	0.05000	0.75000
368	TIG_SPRAY	SS	0.05000	0.25000
369	TIG_SPRAY	Ta	0.05000	0.12500
370	TIG_SPRAY	Th	0.00000	0.00000
371	TIG_SPRAY	Ti	0.05000	0.75000
372	TIG_SPRAY	Tial	0.05000	0.75000
373	TIG_SPRAY	TS	0.05000	0.25000
374	TIG_SPRAY	W	0.05000	0.12500
375	TIG_SPRAY	WC	0.00000	0.00000
376	TIG_SPRAY	U	0.00000	0.00000
377	TIG_SPRAY	V	0.00000	0.00000
378	TIG_SPRAY	Zr	0.05000	0.75000
379	TIG_PULSED	Al	0.05000	0.75000
380	TIG_PULSED	Alal	0.05000	0.75000
381	TIG_PULSED	Cu+Al	0.05000	0.12500
382	TIG_PULSED	Be	0.05000	0.75000
383	TIG_PULSED	Cu+Zn	0.05000	0.12500
384	TIG_PULSED	Cu+Sn	0.05000	0.12500
385	TIG_PULSED	CS	0.05000	0.25000
386	TIG_PULSED	Cc	0.00000	0.00000
387	TIG_PULSED	Cm	0.00000	0.00000
388	TIG_PULSED	Cr	0.05000	0.25000
389	TIG_PULSED	Co	0.00000	0.00000
390	TIG_PULSED	Cu	0.05000	0.12500
391	TIG_PULSED	Cu+Ni	0.05000	0.12500
392	TIG_PULSED	Gr	0.00000	0.00000
393	TIG_PULSED	Au	0.05000	0.75000
394	TIG_PULSED	Gp	0.00000	0.00000
395	TIG_PULSED	GCI	0.05000	0.25000
396	TIG_PULSED	Hf	0.05000	0.75000
397	TIG_PULSED	HCS	0.05000	0.25000
398	TIG_PULSED	Ni+Cr+Fe	0.05000	0.25000
399	TIG_PULSED	Ir	0.00000	0.00000
400	TIG_PULSED	Pb	0.00000	0.00000
401	TIG_PULSED	Sn	0.00000	0.00000
402	TIG_PULSED	Cd	0.00000	0.00000
403	TIG_PULSED	Zn	0.00000	0.00000
404	TIG_PULSED	AS	0.05000	0.25000
405	TIG_PULSED	LCS	0.05000	0.25000
406	TIG_PULSED	Mg	0.05000	0.25000
407	TIG_PULSED	MCI	0.05000	0.25000
408	TIG_PULSED	MCS	0.05000	0.25000
409	TIG_PULSED	Mo	0.05000	0.12500
410	TIG_PULSED	Ni+Cu	0.05000	0.25000
411	TIG_PULSED	Ni	0.05000	0.25000
412	TIG_PULSED	Cu+Zn+Ni	0.05000	0.12500
413	TIG_PULSED	Nm	0.05000	0.25000

414	TIG_PULSED	Nb OR Cb	0.05000	0.12500
415	TIG_PULSED	Pd	0.00000	0.00000
416	TIG_PULSED	Pt	0.05000	0.75000
417	TIG_PULSED	Rn	0.00000	0.00000
418	TIG_PULSED	Rh	0.00000	0.00000
419	TIG_PULSED	Si	0.00000	0.00000
420	TIG_PULSED	Cu+Si	0.05000	0.12500
421	TIG_PULSED	Ag	0.05000	0.75000
422	TIG_PULSED	SS	0.05000	0.25000
423	TIG_PULSED	Ta	0.05000	0.12500
424	TIG_PULSED	Th	0.00000	0.00000
425	TIG_PULSED	Ti	0.05000	0.75000
426	TIG_PULSED	Tial	0.05000	0.75000
427	TIG_PULSED	TS	0.05000	0.25000
428	TIG_PULSED	W	0.05000	0.12500
429	TIG_PULSED	U	0.00000	0.00000
430	TIG_PULSED	V	0.00000	0.00000
431	TIG_PULSED	WC	0.00000	0.00000
432	TIG_PULSED	Zr	0.05000	0.75000
433	PAW	Al	0.06250	0.12500
434	PAW	Alal	0.06250	0.12500
435	PAW	Cu+Al	0.06250	0.25000
436	PAW	Be	0.06250	0.75000
437	PAW	Cu+Zn	0.06250	0.25000
438	PAW	Cu+Sn	0.06250	0.25000
439	PAW	CS	0.06250	0.75000
440	PAW	Cc	0.00000	0.00000
441	PAW	Cm	0.00000	0.00000
442	PAW	Cr	0.06250	0.75000
443	PAW	Co	0.06250	0.75000
444	PAW	Cu	0.06250	0.25000
445	PAW	Cu+Ni	0.06250	0.25000
446	PAW	Gr	0.00000	0.00000
447	PAW	Au	0.06250	0.75000
448	PAW	Gp	0.00000	0.00000
449	PAW	GCI	0.06250	0.50000
450	PAW	Hf	0.06250	0.75000
451	PAW	HCS	0.06250	0.75000
452	PAW	Ni+Cr+Fe	0.06250	0.75000
453	PAW	Ir	0.00000	0.00000
454	PAW	Pb	0.00000	0.00000
455	PAW	Sn	0.00000	0.00000
456	PAW	Cd	0.00000	0.00000
457	PAW	Zn	0.00000	0.00000
458	PAW	AS	0.06250	0.75000
459	PAW	LCS	0.06250	0.75000
460	PAW	Mg	0.06250	0.75000
461	PAW	MCI	0.06250	0.50000
462	PAW	MCS	0.06250	0.75000
463	PAW	Mo	0.00000	0.00000
464	PAW	Ni+Cu	0.06250	0.75000
465	PAW	Ni	0.06250	0.75000
466	PAW	Cu+Zn+Ni	0.06250	0.25000
467	PAW	Nm	0.06250	0.75000
468	PAW	Nb OR Cb	0.06250	0.25000
469	PAW	Pd	0.00000	0.00000
470	PAW	Pt	0.00000	0.00000
471	PAW	Rn	0.00000	0.00000
472	PAW	Rh	0.00000	0.00000
473	PAW	Si	0.00000	0.00000
474	PAW	Cu+Si	0.06250	0.25000
475	PAW	Ag	0.00000	0.00000
476	PAW	SS	0.06250	0.75000
477	PAW	Ta	0.06250	0.25000
478	PAW	Th	0.00000	0.00000
479	PAW	Ti	0.06250	0.75000
480	PAW	Tial	0.06250	0.75000
481	PAW	TS	0.06250	0.00000
482	PAW	W	0.06250	0.25000
483	PAW	U	0.00000	0.00000
484	PAW	V	0.00000	0.00000
485	PAW	WC	0.00000	0.00000

486	PAW	Zr	0.06250	0.75000
487	SAW	Al	0.00000	0.00000
488	SAW	Alal	0.00000	0.00000
489	SAW	Cu+Al	0.25000	100.00000
490	SAW	Be	0.00000	0.00000
491	SAW	Cu+Zn	0.25000	100.00000
492	SAW	Cu+Sn	0.25000	100.00000
493	SAW	CS	0.18750	100.00000
494	SAW	Cc	0.00000	0.00000
495	SAW	Cm	0.00000	0.00000
496	SAW	Cr	0.00000	0.00000
497	SAW	Co	0.00000	0.00000
498	SAW	Cu	0.25000	100.00000
499	SAW	Cu+Ni	0.25000	100.00000
500	SAW	Gr	0.00000	0.00000
501	SAW	Au	0.00000	0.00000
502	SAW	Gp	0.00000	0.00000
503	SAW	GCI	0.25000	100.00000
504	SAW	Hf	0.00000	0.00000
505	SAW	HCS	0.18750	100.00000
506	SAW	Ni+Cr+Fe	0.25000	100.00000
507	SAW	Ir	0.00000	0.00000
508	SAW	Pb	0.00000	0.00000
509	SAW	Sn	0.00000	0.00000
510	SAW	Cd	0.00000	0.00000
511	SAW	Zn	0.00000	0.00000
512	SAW	AS	0.18750	100.00000
513	SAW	LCS	0.18750	100.00000
514	SAW	Mg	0.00000	0.00000
515	SAW	MCI	0.25000	100.00000
516	SAW	MCS	0.18750	100.00000
517	SAW	Mo	0.00000	0.00000
518	SAW	Ni+Cu	0.25000	100.00000
519	SAW	Ni	0.25000	100.00000
520	SAW	Cu+Zn+Ni	0.25000	100.00000
521	SAW	Nm	0.25000	100.00000
522	SAW	Nb OR Cb	0.00000	0.00000
523	SAW	Pd	0.00000	0.00000
524	SAW	Pt	0.00000	0.00000
525	SAW	Rn	0.00000	0.00000
526	SAW	Rh	0.00000	0.00000
527	SAW	Si	0.00000	0.00000
528	SAW	Cu+Si	0.25000	100.00000
529	SAW	Ag	0.00000	0.00000
530	SAW	SS	0.18750	100.00000
531	SAW	Ta	0.00000	0.00000
532	SAW	Th	0.00000	0.00000
533	SAW	Ti	0.00000	0.00000
534	SAW	Tial	0.00000	0.00000
535	SAW	TS	0.18750	100.00000
536	SAW	W	0.00000	0.00000
537	SAW	WC	0.00000	0.00000
538	SAW	U	0.00000	0.00000
539	SAW	V	0.00000	0.00000
540	SAW	Zr	0.00000	0.00000
541	SMAW	Al	0.05000	100.00000
542	SMAW	Alal	0.05000	100.00000
543	SMAW	Cu+Al	0.05000	100.00000
544	SMAW	Be	0.00000	0.00000
545	SMAW	Cu+Zn	0.05000	100.00000
546	SMAW	Cu+Sn	0.05000	100.00000
547	SMAW	CS	0.05000	100.00000
548	SMAW	Cc	0.00000	0.00000
549	SMAW	Cm	0.00000	0.00000
550	SMAW	Cr	0.00000	0.00000
551	SMAW	Co	0.00000	0.00000
552	SMAW	Cu	0.05000	100.00000
553	SMAW	Cu+Ni	0.05000	100.00000
554	SMAW	Gr	0.00000	0.00000
555	SMAW	Au	0.00000	0.00000
556	SMAW	Gp	0.00000	0.00000
557	SMAW	GCI	0.05000	100.00000

558	SMAW	Hf	0.00000	0.00000
559	SMAW	HCS	0.05000	100.00000
560	SMAW	Ni+Cr+Fe	0.05000	100.00000
561	SMAW	Ir	0.00000	0.00000
562	SMAW	Pb	0.00000	0.00000
563	SMAW	Sn	0.00000	0.00000
564	SMAW	Cd	0.00000	0.00000
565	SMAW	Zn	0.00000	0.00000
566	SMAW	AS	0.05000	100.00000
567	SMAW	LCS	0.05000	100.00000
568	SMAW	Mg	0.00000	0.00000
569	SMAW	MCI	0.05000	100.00000
570	SMAW	MCS	0.05000	100.00000
571	SMAW	Mo	0.00000	0.00000
572	SMAW	Ni+Cu	0.05000	100.00000
573	SMAW	Ni	0.05000	100.00000
574	SMAW	Cu+Zn+Ni	0.05000	100.00000
575	SMAW	Nm	0.05000	100.00000
576	SMAW	Nb OR Cb	0.00000	0.00000
577	SMAW	Pd	0.00000	0.00000
578	SMAW	Pt	0.00000	0.00000
579	SMAW	Rn	0.00000	0.00000
580	SMAW	Rh	0.00000	0.00000
581	SMAW	Si	0.00000	0.00000
582	SMAW	Cu+Si	0.05000	100.00000
583	SMAW	Ag	0.00000	0.00000
584	SMAW	SS	0.05000	100.00000
585	SMAW	Ta	0.00000	0.00000
586	SMAW	Th	0.00000	0.00000
587	SMAW	Ti	0.00000	0.00000
588	SMAW	Tial	0.00000	0.00000
589	SMAW	TS	0.05000	100.00000
590	SMAW	W	0.00000	0.00000
591	SMAW	U	0.00000	0.00000
592	SMAW	V	0.00000	0.00000
593	SMAW	WC	0.00000	0.00000
594	SMAW	Zr	0.00000	0.00000
595	ESW	Al	0.00000	0.00000
596	ESW	Alal	0.00000	0.00000
597	ESW	Cu+Al	0.00000	0.00000
598	ESW	Be	0.00000	0.00000
599	ESW	Cu+Zn	0.00000	0.00000
600	ESW	Cu+Sn	0.00000	0.00000
601	ESW	CS	0.75000	100.00000
602	ESW	Cc	0.00000	0.00000
603	ESW	Cm	0.00000	0.00000
604	ESW	Cr	0.00000	0.00000
605	ESW	Co	0.00000	0.00000
606	ESW	Cu	0.00000	0.00000
607	ESW	Cu+Ni	0.00000	0.00000
608	ESW	Gr	0.00000	0.00000
609	ESW	Au	0.00000	0.00000
610	ESW	Gp	0.00000	0.00000
611	ESW	GCI	0.75000	100.00000
612	ESW	Hf	0.00000	0.00000
613	ESW	HCS	0.75000	100.00000
614	ESW	Ni+Cr+Fe	0.75000	100.00000
615	ESW	Ir	0.00000	0.00000
616	ESW	Pb	0.00000	0.00000
617	ESW	Sn	0.00000	0.00000
618	ESW	Cd	0.00000	0.00000
619	ESW	Zn	0.00000	0.00000
620	ESW	AS	0.75000	100.00000
621	ESW	LCS	0.75000	100.00000
622	ESW	Mg	0.00000	0.00000
623	ESW	MCI	0.75000	100.00000
624	ESW	MCS	0.75000	100.00000
625	ESW	Mo	0.00000	0.00000
626	ESW	Ni+Cu	0.75000	100.00000
627	ESW	Ni	0.75000	100.00000
628	ESW	Cu+Zn+Ni	0.00000	0.00000
629	ESW	Nm	0.75000	100.00000

630	ESW	Nb OR Cb	0.00000	0.00000
631	ESW	Pd	0.00000	0.00000
632	ESW	Pt	0.00000	0.00000
633	ESW	Rn	0.00000	0.00000
634	ESW	Rh	0.00000	0.00000
635	ESW	Si	0.00000	0.00000
636	ESW	Cu+Si	0.00000	0.00000
637	ESW	Ag	0.00000	0.00000
638	ESW	SS	0.75000	100.00000
639	ESW	Ta	0.00000	0.00000
640	ESW	Th	0.00000	0.00000
641	ESW	Ti	0.75000	100.00000
642	ESW	Tial	0.75000	100.00000
643	ESW	TS	0.75000	100.00000
644	ESW	W	0.00000	0.00000
645	ESW	WC	0.00000	0.00000
646	ESW	U	0.00000	0.00000
647	ESW	V	0.75000	100.00000
648	ESW	Zr	0.75000	100.00000
649	BRAZING	Al	0.00000	100.00000
650	BRAZING	Alal	0.00000	100.00000
651	BRAZING	Cu+Al	0.00000	100.00000
652	BRAZING	Be	0.00000	0.00000
653	BRAZING	Cu+Zn	0.00000	100.00000
654	BRAZING	Cu+Sn	0.00000	100.00000
655	BRAZING	CS	0.00000	100.00000
656	BRAZING	Cc	0.00000	100.00000
657	BRAZING	Cm	0.00000	100.00000
658	BRAZING	Cr	0.00000	0.00000
659	BRAZING	Co	0.00000	0.00000
660	BRAZING	Cu	0.00000	100.00000
661	BRAZING	Cu+Ni	0.00000	100.00000
662	BRAZING	Gr	0.00000	0.00000
663	BRAZING	Au	0.00000	100.00000
664	BRAZING	Gp	0.00000	100.00000
665	BRAZING	GCI	0.00000	100.00000
666	BRAZING	Hf	0.00000	0.00000
667	BRAZING	HCS	0.00000	100.00000
668	BRAZING	Ni+Cr+Fe	0.00000	100.00000
669	BRAZING	Ir	0.00000	0.00000
670	BRAZING	Pb	0.00000	0.00000
671	BRAZING	Sn	0.00000	100.00000
672	BRAZING	Cd	0.00000	100.00000
673	BRAZING	Zn	0.00000	0.00000
674	BRAZING	AS	0.00000	100.00000
675	BRAZING	LCS	0.00000	100.00000
676	BRAZING	Mg	0.00000	0.75000
677	BRAZING	MCI	0.00000	100.00000
678	BRAZING	MCS	0.00000	100.00000
679	BRAZING	Mo	0.00000	0.25000
680	BRAZING	Ni+Cu	0.00000	100.00000
681	BRAZING	Ni	0.00000	100.00000
682	BRAZING	Cu+Zn+Ni	0.00000	100.00000
683	BRAZING	Nm	0.00000	100.00000
684	BRAZING	Nb OR Cb	0.00000	0.25000
685	BRAZING	Pd	0.00000	0.00000
686	BRAZING	Pt	0.00000	0.00000
687	BRAZING	Rn	0.00000	0.00000
688	BRAZING	Rh	0.00000	0.00000
689	BRAZING	Si	0.00000	0.00000
690	BRAZING	Cu+Si	0.00000	100.00000
691	BRAZING	Ag	0.00000	100.00000
692	BRAZING	SS	0.00000	100.00000
693	BRAZING	Ta	0.00000	100.00000
694	BRAZING	Th	0.00000	0.00000
695	BRAZING	Ti	0.00000	100.00000
696	BRAZING	Tial	0.00000	100.00000
697	BRAZING	TS	0.00000	100.00000
698	BRAZING	W	0.00000	0.25000

699	BRAZING	U	0.00000	0.00000
700	BRAZING	V	0.00000	0.00000
701	BRAZING	WC	0.00000	0.00000
702	BRAZING	Zr	0.00000	0.00000
703	DFW	Al	0.00000	0.25000
704	DFW	Alal	0.00000	0.25000
705	DFW	Cu+Al	0.00000	100.00000
706	DFW	Be	0.00000	100.00000
707	DFW	Cu+Zn	0.00000	100.00000
708	DFW	Cu+Sn	0.00000	100.00000
709	DFW	CO	0.00000	100.00000
710	DFW	Cc	0.00000	100.00000
711	DFW	Cm	0.00000	100.00000
712	DFW	Cr	0.00000	100.00000
713	DFW	Co	0.00000	100.00000
714	DFW	Cu	0.00000	100.00000
715	DFW	Cu+Ni	0.00000	100.00000
716	DFW	Cr	0.00000	0.00000
717	DFW	Au	0.00000	100.00000
718	DFW	Cp	0.00000	0.00000
719	DFW	GCI	0.00000	100.00000
720	DFW	Hf	0.00000	0.00000
721	DFW	HCS	0.00000	100.00000
722	DFW	Ni+Cr+Fe	0.00000	100.00000
723	DFW	Ir	0.00000	100.00000
724	DFW	Pb	0.00000	0.00000
725	DFW	Sn	0.00000	0.00000
726	DFW	Cd	0.00000	0.00000
727	DFW	Zn	0.00000	0.00000
728	DFW	AC	0.00000	100.00000
729	DFW	LCS	0.00000	100.00000
730	DFW	Mg	0.00000	100.00000
731	DFW	MCI	0.00000	100.00000
732	DFW	MCS	0.00000	100.00000
733	DFW	Mo	0.00000	100.00000
734	DFW	Ni+Cu	0.00000	100.00000
735	DFW	Ni	0.00000	100.00000
736	DFW	Cu+Zn+Ni	0.00000	100.00000
737	DFW	Nm	0.00000	100.00000
738	DFW	Nb OR Cb	0.00000	100.00000
739	DFW	Pd	0.00000	100.00000
740	DFW	Pt	0.00000	100.00000

741	DFW	Rn	0.00000	0.00000
742	DFW	Rh	0.00000	0.00000
743	DFW	Si	0.00000	0.00000
744	DFW	Cu+Si	0.00000	0.00000
745	DFW	Ag	0.00000	100.00000
746	DFW	SS	0.00000	100.00000
747	DFW	Ta	0.00000	100.00000
748	DFW	Th	0.00000	0.00000
749	DFW	Ti	0.00000	100.00000
750	DFW	Tial	0.00000	100.00000
751	DFW	TS	0.00000	100.00000
752	DFW	W	0.00000	100.00000
753	DFW	WC	0.00000	0.00000
754	DFW	U	0.00000	100.00000
755	DFW	V	0.00000	100.00000
756	DFW	Zr	0.00000	100.00000
757	EBW	Al	0.00000	100.00000
758	EBW	Alal	0.00000	100.00000
759	EBW	Cu+Al	0.00000	100.00000
760	EBW	Be	0.00000	100.00000
761	EBW	Cu+Zn	0.00000	100.00000
762	EBW	Cu+Sn	0.00000	100.00000
763	EBW	CS	0.00000	100.00000
764	EBW	Cc	0.00000	0.00000
765	EBW	Cm	0.00000	0.00000
766	EBW	Cr	0.00000	0.00000
767	EBW	Co	0.00000	100.00000
768	EBW	Cu	0.00000	100.00000
769	EBW	Cu+Ni	0.00000	100.00000
770	EBW	Gr	0.00000	0.00000
771	EBW	Au	0.00000	100.00000
772	EBW	Gp	0.00000	0.00000
773	EBW	GCI	0.00000	100.00000
774	EBW	Hf	0.00000	100.00000
775	EBW	HCS	0.00000	100.00000
776	EBW	Ni+Cr+Fe	0.00000	100.00000
777	EBW	Ir	0.00000	100.00000
778	EBW	Pb	0.00000	0.00000
779	EBW	Sn	0.00000	0.00000
780	EBW	Cd	0.00000	0.00000
781	EBW	Zn	0.00000	0.00000
782	EBW	AS	0.00000	100.00000
783	EBW	LCS	0.00000	100.00000
784	EBW	Mg	0.00000	100.00000
785	EBW	MCI	0.00000	100.00000
786	EBW	MCS	0.00000	100.00000
787	EBW	Mo	0.00000	0.25000
788	EBW	Ni+Cu	0.00000	100.00000
789	EBW	Ni	0.00000	100.00000
790	EBW	Cu+Zn+Ni	0.00000	100.00000
791	EBW	Nm	0.00000	100.00000
792	EBW	Nb OR Cb	0.00000	0.25000
793	EBW	Pd	0.00000	100.00000
794	EBW	Pt	0.00000	100.00000
795	EBW	Rn	0.00000	100.00000
796	EBW	Rh	0.00000	0.00000
797	EBW	Si	0.00000	0.00000
798	EBW	Cu+Si	0.00000	100.00000
799	EBW	Ag	0.00000	100.00000
800	EBW	SS	0.00000	100.00000
801	EBW	Ta	0.00000	0.25000
802	EBW	Th	0.00000	100.00000
803	EBW	Ti	0.00000	100.00000
804	EBW	Tial	0.00000	100.00000
805	EBW	TS	0.00000	100.00000
806	EBW	W	0.00000	0.25000
807	EBW	WC	0.00000	0.00000
808	EBW	U	0.00000	100.00000
809	EBW	V	0.00000	100.00000

810	EBW	Zr	0.00000	100.00000
811	EXW	Al	0.00000	100.00000
812	EXW	Alal	0.00000	100.00000
813	EXW	Cu+Al	0.00000	100.00000
814	EXW	Be	0.00000	0.00000
815	EXW	Cu+Zn	0.00000	100.00000
816	EXW	Cu+Sn	0.00000	100.00000
817	EXW	CS	0.00000	0.75000
818	EXW	Cc	0.00000	0.00000
819	EXW	Cm	0.00000	0.00000
820	EXW	Cr	0.00000	0.00000
821	EXW	Co	0.00000	0.00000
822	EXW	Cu	0.00000	100.00000
823	EXW	Cu+Ni	0.00000	100.00000
824	EXW	Gr	0.00000	0.00000
825	EXW	Au	0.00000	0.00000
826	EXW	Gp	0.00000	0.00000
827	EXW	GCI	0.00000	0.00000
828	EXW	Hf	0.00000	0.00000
829	EXW	HCS	0.00000	0.75000
830	EXW	Ni+Cr+Fe	0.00000	0.75000
831	EXW	Ir	0.00000	100.00000
832	EXW	Pb	0.00000	0.00000
833	EXW	Sn	0.00000	0.00000
834	EXW	Cd	0.00000	0.00000
835	EXW	Zn	0.00000	0.00000
836	EXW	AS	0.00000	0.75000
837	EXW	LCS	0.00000	0.75000
838	EXW	Mg	0.00000	100.00000
839	EXW	MCI	0.00000	0.00000
840	EXW	MCS	0.00000	0.75000
841	EXW	Mo	0.00000	0.00000
842	EXW	Ni+Cu	0.00000	0.75000
843	EXW	Ni	0.00000	0.75000
844	EXW	Cu+Zn+Ni	0.00000	100.00000
845	EXW	Nm	0.00000	0.75000
846	EXW	Nb OR Cb	0.00000	0.75000
847	EXW	Pd	0.00000	100.00000
848	EXW	Pt	0.00000	100.00000
849	EXW	Rn	0.00000	0.00000
850	EXW	Rh	0.00000	0.00000
851	EXW	Si	0.00000	0.00000
852	EXW	Cu+Si	0.00000	100.00000
853	EXW	Ag	0.00000	100.00000
854	EXW	SS	0.00000	0.75000
855	EXW	Ta	0.00000	0.75000
856	EXW	Th	0.00000	0.00000
857	EXW	Ti	0.00000	100.00000
858	EXW	Tial	0.00000	100.00000
859	EXW	TS	0.00000	0.75000
860	EXW	W	0.00000	0.00000
861	EXW	WC	0.00000	0.00000
862	EXW	U	0.00000	0.00000
863	EXW	V	0.00000	0.00000
864	EXW	Zr	0.00000	100.00000
865	FRW	Al	0.12500	100.00000
866	FRW	Alal	0.12500	100.00000
867	FRW	Cu+Al	0.12500	100.00000
868	FRW	Be	0.00000	0.00000
869	FRW	Cu+Zn	0.12500	100.00000
870	FRW	Cu+Sn	0.12500	100.00000
871	FRW	CS	0.12500	100.00000
872	FRW	Cc	0.00000	0.00000
873	FRW	Cm	0.00000	0.00000
874	FRW	Cr	0.00000	0.00000
875	FRW	Co	0.12500	100.00000
876	FRW	Cu	0.12500	100.00000
877	FRW	Cu+Ni	0.12500	100.00000
878	FRW	Gr	0.00000	0.00000
879	FRW	Au	0.00000	0.00000
880	FRW	Gp	0.00000	0.00000
881	FRW	GCI	0.00000	0.00000

882	FRW	Hf	0.00000	0.00000
883	FRW	HCS	0.12500	100.00000
884	FRW	Ni+Cr+Fe	0.12500	100.00000
885	FRW	Ir	0.00000	0.00000
886	FRW	Pb	0.12500	100.00000
887	FRW	Sn	0.12500	100.00000
888	FRW	Cd	0.12500	100.00000
889	FRW	Zn	0.00000	0.00000
890	FRW	AS	0.12500	100.00000
891	FRW	LCS	0.12500	100.00000
892	FRW	Mg	0.12500	100.00000
893	FRW	MCI	0.00000	0.00000
894	FRW	MCS	0.12500	100.00000
895	FRW	Mo	0.12500	100.00000
896	FRW	Ni+Cu	0.12500	100.00000
897	FRW	Ni	0.12500	100.00000
898	FRW	Cu+Zn+Ni	0.12500	100.00000
899	FRW	Nm	0.12500	100.00000
900	FRW	Nb OR Cb	0.12500	100.00000
901	FRW	Pd	0.00000	0.00000
902	FRW	Pt	0.00000	0.00000
903	FRW	Rn	0.00000	0.00000
904	FRW	Rh	0.00000	0.00000
905	FRW	Si	0.00000	0.00000
906	FRW	Cu+Si	0.12500	100.00000
907	FRW	Ag	0.00000	0.00000
908	FRW	SS	0.12500	100.00000
909	FRW	Ta	0.12500	100.00000
910	FRW	Th	0.12500	100.00000
911	FRW	Ti	0.12500	100.00000
912	FRW	Tial	0.12500	100.00000
913	FRW	TS	0.12500	100.00000
914	FRW	W	0.12500	100.00000
915	FRW	WC	0.00000	0.00000
916	FRW	U	0.12500	100.00000
917	FRW	V	0.00000	0.00000
918	FRW	Zr	0.12500	100.00000
919	LBW	Al	0.00000	0.25000
920	LBW	Alal	0.00000	0.25000
921	LBW	Cu+Al	0.00000	0.75000
922	LBW	Be	0.00000	0.00000
923	LBW	Cu+Zn	0.00000	0.75000
924	LBW	Cu+Sn	0.00000	0.75000
925	LBW	CS	0.00000	0.75000
926	LBW	Cc	0.00000	0.00000
927	LBW	Cm	0.00000	0.00000
928	LBW	Cr	0.00000	0.00000
929	LBW	Co	0.00000	0.00000
930	LBW	Cu	0.00000	0.75000
931	LBW	Cu+Ni	0.00000	0.75000
932	LBW	Gr	0.00000	0.00000
933	LBW	Au	0.00000	0.75000
934	LBW	Gp	0.00000	0.00000
935	LBW	GCI	0.00000	0.00000
936	LBW	Hf	0.00000	0.75000
937	LBW	HCS	0.00000	0.75000
938	LBW	Ni+Cr+Fe	0.00000	0.75000
939	LBW	Ir	0.00000	0.75000
940	LBW	Pb	0.00000	0.00000
941	LBW	Sn	0.00000	0.00000
942	LBW	Cd	0.00000	0.00000
943	LBW	Zn	0.00000	0.00000
944	LBW	AS	0.00000	0.75000
945	LBW	LCS	0.00000	0.75000
946	LBW	Mg	0.00000	0.75000
947	LBW	MCI	0.00000	0.00000
948	LBW	MCS	0.00000	0.75000

949	LBW	Mo	0.00000	0.75000
950	LBW	Ni+Cu	0.00000	0.75000
951	LBW	Ni	0.00000	0.75000
952	LBW	Cu+Zn+Ni	0.00000	0.75000
953	LBW	Nm	0.00000	0.75000
954	LBW	Nb OR Cb	0.00000	0.75000
955	LBW	Pd	0.00000	0.75000
956	LBW	Pt	0.00000	0.75000
957	LBW	Rn	0.00000	0.00000
958	LBW	Rh	0.00000	0.00000
959	LBW	Si	0.00000	0.00000
960	LBW	Cu+Si	0.00000	0.75000
961	LBW	Ag	0.00000	0.75000
962	LBW	SS	0.00000	0.75000
963	LBW	Ta	0.00000	0.75000
964	LBW	Th	0.00000	0.00000
965	LBW	Ti	0.00000	0.75000
966	LBW	Tial	0.00000	0.75000
967	LBW	TS	0.00000	0.75000
968	LBW	W	0.00000	0.75000
969	LBW	WC	0.00000	0.00000
970	LBW	U	0.00000	0.00000
971	LBW	V	0.00000	0.00000
972	LBW	Zr	0.00000	0.75000
973	SOLDERING	Al	0.00000	0.12500
974	SOLDERING	Alal	0.00000	0.12500
975	SOLDERING	Cu+Al	0.00000	0.12500
976	SOLDERING	Be	0.00000	0.00000
977	SOLDERING	Cu+Zn	0.00000	0.12500
978	SOLDERING	Cu+Sn	0.00000	0.12500
979	SOLDERING	CS	0.00000	0.12500
980	SOLDERING	Cc	0.00000	0.12500
981	SOLDERING	Cm	0.00000	0.12500
982	SOLDERING	Cr	0.00000	0.12500
983	SOLDERING	Co	0.00000	0.00000
984	SOLDERING	Cu	0.00000	0.12500
985	SOLDERING	Cu+Ni	0.00000	0.12500
986	SOLDERING	Gr	0.00000	0.00000
987	SOLDERING	Au	0.00000	0.12500
988	SOLDERING	Gp	0.00000	0.12500
989	SOLDERING	GCI	0.00000	0.00000
990	SOLDERING	Hf	0.00000	0.00000
991	SOLDERING	HCS	0.00000	0.12500
992	SOLDERING	Ni+Cr+Fe	0.00000	0.12500
993	SOLDERING	Ir	0.00000	0.00000
994	SOLDERING	Pb	0.00000	0.12500
995	SOLDERING	Sn	0.00000	0.12500
996	SOLDERING	Cd	0.00000	0.12500
997	SOLDERING	Zn	0.00000	0.12500
998	SOLDERING	AS	0.00000	0.12500
999	SOLDERING	LCS	0.00000	0.12500
1000	SOLDERING	Mg	0.00000	0.00000
1001	SOLDERING	MCI	0.00000	0.00000
1002	SOLDERING	MCS	0.00000	0.12500
1003	SOLDERING	Mo	0.00000	0.00000
1004	SOLDERING	Ni+Cu	0.00000	0.12500
1005	SOLDERING	Ni	0.00000	0.12500
1006	SOLDERING	Cu+Zn+Ni	0.00000	0.12500
1007	SOLDERING	Nm	0.00000	0.12500
1008	SOLDERING	Nb OR Cb	0.00000	0.00000
1009	SOLDERING	Pd	0.00000	0.12500
1010	SOLDERING	Pt	0.00000	0.12500
1011	SOLDERING	Rn	0.00000	0.12500
1012	SOLDERING	Rh	0.00000	0.12500
1013	SOLDERING	Si	0.00000	0.00000
1014	SOLDERING	Cu+Si	0.00000	0.12500
1015	SOLDERING	Ag	0.00000	0.12500
1016	SOLDERING	SS	0.00000	0.12500
1017	SOLDERING	Ta	0.00000	0.00000

1018	SOLDERING	Th	0.00000	0.00000
1019	SOLDERING	Ti	0.00000	0.00000
1020	SOLDERING	Tial	0.00000	0.00000
1021	SOLDERING	TS	0.00000	0.12500
1022	SOLDERING	W	0.00000	0.00000
1023	SOLDERING	WC	0.00000	0.00000
1024	SOLDERING	U	0.00000	0.00000
1025	SOLDERING	V	0.00000	0.00000
1026	SOLDERING	Zr	0.00000	0.00000
1027	USW	Al	0.00000	0.25000
1028	USW	Alal	0.00000	0.25000
1029	USW	Cu+Al	0.00000	0.12500
1030	USW	Be	0.00000	0.12500
1031	USW	Cu+Zn	0.00000	0.12500
1032	USW	Cu+Sn	0.00000	0.12500
1033	USW	CS	0.00000	0.12500
1034	USW	Cc	0.00000	0.00000
1035	USW	Cm	0.00000	0.00000
1036	USW	Cr	0.00000	0.00000
1037	USW	Co	0.00000	0.00000
1038	USW	Cu	0.00000	0.12500
1039	USW	Cu+Ni	0.00000	0.12500
1040	USW	Gr	0.00000	0.00000
1041	USW	Au	0.00000	0.12500
1042	USW	Gp	0.00000	0.00000
1043	USW	GCI	0.00000	0.12500
1044	USW	Hf	0.00000	0.00000
1045	USW	HCS	0.00000	0.12500
1046	USW	Ni+Cr+Fe	0.00000	0.12500
1047	USW	Ir	0.00000	0.00000
1048	USW	Pb	0.00000	0.00000
1049	USW	Sn	0.00000	0.00000
1050	USW	Cd	0.00000	0.00000
1051	USW	Zn	0.00000	0.00000
1052	USW	AS	0.00000	0.12500
1053	USW	LCS	0.00000	0.12500
1054	USW	Mg	0.00000	0.12500
1055	USW	MCI	0.00000	0.12500
1056	USW	MCS	0.00000	0.12500
1057	USW	Mo	0.00000	0.12500
1058	USW	Ni+Cu	0.00000	0.12500
1059	USW	Ni	0.00000	0.12500
1060	USW	Cu+Zn+Ni	0.00000	0.12500
1061	USW	Nm	0.00000	0.12500
1062	USW	Nb OR Cb	0.00000	0.12500
1063	USW	Pd	0.00000	0.12500
1064	USW	Pt	0.00000	0.12500
1065	USW	Rn	0.00000	0.00000
1066	USW	Rh	0.00000	0.00000
1067	USW	Si	0.00000	0.00000
1068	USW	Cu+Si	0.00000	0.12500
1069	USW	Ag	0.00000	0.12500
1070	USW	SS	0.00000	0.12500
1061	USW	Nm	0.00000	0.12500
1062	USW	Nb OR Cb	0.00000	0.12500
1063	USW	Pd	0.00000	0.12500
1064	USW	Pt	0.00000	0.12500
1065	USW	Rn	0.00000	0.00000
1066	USW	Rh	0.00000	0.00000
1067	USW	Si	0.00000	0.00000
1068	USW	Cu+Si	0.00000	0.12500
1069	USW	Ag	0.00000	0.12500
1070	USW	SS	0.00000	0.12500
1071	USW	Ta	0.00000	0.12500
1072	USW	Th	0.00000	0.00000
1073	USW	Ti	0.00000	0.12500
1074	USW	Tial	0.00000	0.12500

1075	USW	TS	0.00000	0.12500
1076	USW	W	0.00000	0.12500
1077	USW	WC	0.00000	0.00000
1078	USW	U	0.00000	0.00000
1079	USW	V	0.00000	0.00000
1080	USW	Zr	0.00000	0.12500

PROPOSI.DBF (Processes based on welding position)

Fields name → / Records ↓	Process (Process)	Flat position (Flat)	Horizontal position (Horizontal)	Vertical position (Vertical)	Overhead position (Overhead)
1	CAW	Y	Y	Y	Y
2	SMAW	Y	Y	Y	Y
3	EGW	N	N	Y	N
4	ESW	N	N	Y	N
5	PAW	Y	Y	N	N
6	SAW	Y	Y	Y	N
7	TIG_SPRAY	Y	Y	Y	Y
8	TIG_PULSED	Y	Y	Y	Y
9	MIG_PULSED	Y	Y	Y	Y
10	MIG_SPRAY	Y	Y	Y	Y
11	MIG_SHORT-DIP	Y	Y	Y	Y
12	FCAW	Y	Y	Y	Y
13	USW	Y	Y	Y	Y
14	DFW	Y	Y	Y	Y
15	FRW	Y	Y	Y	Y
16	SOLDERING	Y	Y	Y	Y
17	BRAZING	Y	Y	Y	Y
18	EXW	Y	Y	Y	Y
19	LBW	Y	Y	Y	Y
20	EBW	Y	Y	Y	Y

PROENV.DBF (Processes based on welding environment)

Fields name → / Records ↓	Process (Process)	Outdoor equipment (Outdoor)
1	CAW	Y
2	SMAW	Y
3	EGW	Y
4	ESW	Y
5	TIG_SPRAY	N
6	TIG_PULSED	N
7	MIG_PULSED	N
8	MIG_SPRAY	N
9	MIG_SHORT-DIP	N
10	PAW	Y
11	SAW	Y
12	FCAW	Y
13	USW	Y
14	FRW	Y
15	DFW	Y
16	LBW	Y
17	EBW	Y
18	EXW	Y
19	BRAZING	Y
20	SOLDERING	Y

PROCESS.DBF (Processes based on welded job application)

Fields name → / Records ↓	Process (Process)	Fatigue (Fatigue)
1	CAW	Y
2	SAW	Y
3	PAW	Y
4	SMAW	Y
5	ESW	Y
6	EGW	Y
7	TIG_SPRAY	Y
8	TIG_PULSED	Y
9	MIG_PULSED	Y
10	MIG_SPRAY	Y
11	MIG_SHORT-DIP	Y
12	FCAW	Y
13	BRAZING	N
14	SOLDERING	N
15	DFW	Y
16	FRW	Y
17	LBW	Y
18	EBW	Y
19	EXW	Y
20	USW	Y

CRITERIA.DBF (Processes sequence based on various scoring criteria)

Fields name → / Records ↓	Process (Process)	Welding Speed (Weld_Speed)	Distortion (Distortion)	Set-up Cost (Cost)
1	CAW	1	12	18
2	SMAW	2	10	11
3	EGW	3	2	8
4	ESW	4	1	7
5	PAW	5	4	9
6	SAW	6	3	12
7	TIG_SPRAY	7	5	17
8	TIG_PULSED	8	6	16
9	FCAW	9	11	10
10	MIG_SPRAY	10	7	15
11	MIG_PULSED	11	9	13
12	MIG-SHORT_DIP	12	8	14
13	USW	13	18	3
14	DFW	14	16	6
15	FRW	15	17	5
16	SOLDERING	16	20	20
17	BRAZING	17	19	19
18	EXW	18	15	4
19	LBW	19	14	1
20	EBW	20	13	2

(Groove joint design and preparation)

		Position	Lower	Upper	Code	
1	CAW	1	0.00000	0.25000	A1	SQUARE GROOVE
2	CAW	1	0.25000	0.75000	A1	SQUARE GROOVE
3	CAW	3	0.00000	0.00000	N	CAW NOT USED
4	CAW	4	0.00000	0.25000	A1	SQUARE GROOVE
5	CAW	4	0.25000	0.75000	A1	SQUARE GROOVE
6	CAW	5	0.00000	0.25000	A1	NOT SPECIFIC,JOBS MACHINED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
7	CAW	5	0.25000	0.75000	A1	NOT SPECIFIC,JOBS MACHINED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
8	EGW	1	0.25000	0.37500	B	SQUARE GROOVE (WITH COPPER DAM)
9	EGW	1	0.25000	0.37500	B	SINGLE V GROOVE (WITH COPPER DAM)
10	EGW	1	0.37500	0.50000	B	SQUARE GROOVE (WITH COPPER DAM)
11	EGW	1	0.37500	0.50000	B	SINGLE V GROOVE (WITH COPPER DAM)
12	EGW	1	0.50000	0.75000	B	SQUARE GROOVE (WITH COPPER DAM)
13	EGW	1	0.50000	0.75000	B	SINGLE V GROOVE (WITH COPPER DAM)
14	EGW	1	0.75000	100.00000	B	SQUARE GROOVE (WITH COPPER DAM)
15	EGW	1	0.70000	100.00000	C	DOUBLE V GROOVE (WITH COPPER DAM)
16	EGW	4	0.25000	0.37500	B	SQUARE GROOVE (WITH COPPER DAM)
17	EGW	4	0.25000	0.37500	B	SINGLE V GROOVE (WITH COPPER DAM)
18	EGW	4	0.37500	0.50000	B	SQUARE GROOVE (WITH COPPER DAM)
19	EGW	4	0.37500	0.50000	B	SINGLE V GROOVE (WITH COPPER DAM)
20	EGW	4	0.50000	0.75000	B	SQUARE GROOVE (WITH COPPER DAM)
21	EGW	4	0.50000	0.75000	B	SINGLE V GROOVE (WITH COPPER DAM)
22	EGW	4	0.75000	100.00000	B	SQUARE GROOVE (WITH COPPER DAM)
23	EGW	4	0.75000	100.00000	C	DOUBLE V GROOVE (WITH COPPER DAM)
24	EGW	3	0.00000	0.00000	N	EGW NOT USED
25	EGW	5	0.25000	0.50000	A1	NOT SPECIFIC,JOBS MACHINED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
26	EGW	5	0.50000	100.00000	A1	NOT SPECIFIC,JOBS MACHINED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
27	ESW	1	0.75000	1.50000	A1	SQUARE GROOVE
28	ESW	1	1.50000	2.50000	A1	SQUARE GROOVE
29	ESW	1	2.50000	100.00000	A1	SQUARE GROOVE
30	ESW	4	0.75000	1.50000	A1	SQUARE GROOVE
31	ESW	4	1.50000	2.50000	A1	SQUARE GROOVE
32	ESW	4	2.50000	100.00000	A1	SQUARE GROOVE
33	ESW	3	0.00000	0.00000	N	ESW NOT USED

34	ESW	5	0.75000	1.50000 A1	NOT SPECIFIC,JOBS MACHINED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
35	ESW	5	1.50000	2.50000 A1	NOT SPECIFIC,JOBS MACHINED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
36	ESW	5	2.50000	100.00000 A1	NOT SPECIFIC,JOBS MACHINED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
37	FCAW	1	0.00000	0.12500 A1	SQUARE GROOVE
38	FCAW	1	0.00000	0.12500 B	SQUARE GROOVE
39	FCAW	1	0.12500	0.25000 A2	SQUARE GROOVE
40	FCAW	1	0.12500	0.25000 B	SQUARE GROOVE
41	FCAW	1	0.25000	0.37500 A2	SINGLE V GROOVE
42	FCAW	1	0.25000	0.37500 B	SINGLE V GROOVE
43	FCAW	1	0.25000	0.37500 B	SINGLE BEVEL GROOVE
44	FCAW	1	0.25000	0.37500 A2	SINGLE BEVEL GROOVE
45	FCAW	1	0.37500	0.50000 A2	SINGLE V GROOVE
46	FCAW	1	0.37500	0.50000 A2	SINGLE BEVEL GROOVE
47	FCAW	1	0.37500	0.50000 B	SINGLE V GROOVE
48	FCAW	1	0.37500	0.50000 B	SINGLE BEVEL GROOVE
49	FCAW	1	0.37500	0.50000 B	SINGLE U GROOVE
50	FCAW	1	0.37500	0.50000 B	SINGLE J GROOVE
51	FCAW	1	0.50000	0.75000 A2	SINGLE V GROOVE
52	FCAW	1	0.50000	0.75000 A2	SINGLE BEVEL GROOVE
53	XYZ	1	0.50000	0.75000 B	SINGLE V GROOVE
54	FCAW	1	0.50000	0.75000 B	SINGLE V GROOVE
55	FCAW	1	0.50000	0.75000 B	SINGLE BEVEL GROOVE
56	FCAW	1	0.50000	0.75000 B	SINGLE U GROOVE
57	FCAW	1	0.50000	0.75000 B	SINGLE J GROOVE
58	FCAW	1	0.75000	100.00000 C	DOUBLE V GROOVE
59	FCAW	1	0.75000	100.00000 C	DOUBLE BEVEL GROOVE
60	FCAW	1	0.75000	100.00000 C	DOUBLE U GROOVE
61	FCAW	1	0.75000	100.00000 C	DOUBLE J GROOVE
62	FCAW	1	0.75000	100.00000 A2	SINGLE V GROOVE
63	FCAW	1	0.75000	100.00000 A2	SINGLE BEVEL GROOVE
64	FCAW	3	0.00000	0.50000 A2	SINGLE BEVEL GROOVE
65	FCAW	3	0.00000	0.50000 A2	SINGLE BEVEL GROOVE
66	FCAW	3	0.00000	0.50000 A1	SINGLE BEVEL GROOVE
67	FCAW	3	0.00000	0.50000 A1	SINGLE J GROOVE

68	FCAW	3	0.00000	0.50000	B	SINGLE J GROOVE
69	FCAW	3	0.00000	0.50000	B	SINGLE BEVEL GROOVE
70	FCAW	3	0.50000	100.00000	C	DOUBLE BEVEL GROOVE
71	FCAW	3	0.50000	100.00000	C	DOUBLE J GROOVE
72	FCAW	4	0.00000	0.12500	A1	SQUARE GROOVE
73	FCAW	4	0.00000	0.12500	B	SQUARE GROOVE
74	FCAW	4	0.12500	0.25000	A2	SQUARE GROOVE
75	FCAW	4	0.12500	0.25000	B	SQUARE GROOVE
76	FCAW	4	0.25000	0.37500	A2	SINGLE V GROOVE
77	FCAW	4	0.25000	0.37500	B	SINGLE V GROOVE
78	FCAW	4	0.25000	0.37500	B	SINGLE BEVEL GROOVE
79	FCAW	4	0.25000	0.37500	A2	SINGLE BEVEL GROOVE
80	FCAW	4	0.37500	0.50000	A2	SINGLE BEVEL GROOVE
81	FCAW	4	0.37500	0.50000	A2	SINGLE V GROOVE
82	FCAW	4	0.37500	0.50000	B	SINGLE V GROOVE
83	FCAW	4	0.37500	0.50000	B	SINGLE BEVEL GROOVE
84	FCAW	4	0.37500	0.50000	B	SINGLE U GROOVE
85	FCAW	4	0.37500	0.50000	B	SINGLE J GROOVE
86	FCAW	4	0.50000	0.75000	A2	SINGLE V GROOVE
87	FCAW	4	0.50000	0.75000	A2	SINGLE BEVEL GROOVE
88	XYZ	4	0.50000	0.75000	B	SINGLE V GROOVE
89	FCAW	4	0.50000	0.75000	B	SINGLE V GROOVE
90	FCAW	4	0.50000	0.75000	B	SINGLE BEVEL GROOVE
91	FCAW	4	0.50000	0.75000	B	SINGLE U GROOVE
92	FCAW	4	0.50000	0.75000	B	SINGLE J GROOVE
93	FCAW	4	0.75000	100.00000	C	DOUBLE V GROOVE
94	FCAW	4	0.75000	100.00000	C	DOUBLE BEVEL GROOVE
95	FCAW	4	0.75000	100.00000	C	DOUBLE U GROOVE
96	FCAW	4	0.75000	100.00000	C	DOUBLE J GROOVE
97	FCAW	4	0.75000	100.00000	A2	SINGLE V GROOVE
98	FCAW	4	0.75000	100.00000	A2	SINGLE BEVEL GROOVE
99	FCAW	5	0.00000	0.50000	A1	NOT SPECIFIED,JOBS MACHINED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
100	FCAW	5	0.50000	100.00000	A1	NOT SPECIFIED,JOBS MACHINED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
101	MIG	1	0.00000	0.12500	A1	SQUARE GROOVE
102	MIG	1	0.00000	0.12500	B	SQUARE GROOVE

103	MIG	1	0.12500	0.25000	A2	SQUARE GROOVE
104	MIG	1	0.12500	0.25000	B	SQUARE GROOVE
105	MIG	1	0.25000	0.37500	A2	SINGLE V GROOVE
106	MIG	1	0.25000	0.37500	B	SINGLE V GROOVE
107	MIG	1	0.25000	0.37500	B	SINGLE BEVEL GROOVE
108	MIG	1	0.25000	0.37500	A2	SINGLE BEVEL GROOVE
109	MIG	1	0.37500	0.50000	A2	SINGLE BEVEL GROOVE
110	MIG	1	0.37500	0.50000	A2	SINGLE V GROOVE
111	MIG	1	0.37500	0.50000	B	SINGLE V GROOVE
112	MIG	1	0.37500	0.50000	B	SINGLE BEVEL GROOVE
113	MIG	1	0.37500	0.50000	B	SINGLE U GROOVE
114	MIG	1	0.37500	0.50000	B	SINGLE J GROOVE
115	MIG	1	0.50000	0.75000	A2	SINGLE V GROOVE
116	MIG	1	0.50000	0.75000	A2	SINGLE BEVEL GROOVE
117	XYZ	1	0.50000	0.75000	B	SINGLE V GROOVE
118	MIG	1	0.50000	0.75000	B	SINGLE V GROOVE
119	MIG	1	0.50000	0.75000	B	SINGLE BEVEL GROOVE
120	MIG	1	0.50000	0.75000	B	SINGLE U GROOVE
121	MIG	1	0.50000	0.75000	B	SINGLE J GROOVE
122	MIG	1	0.75000	100.00000	C	DOUBLE V GROOVE
123	MIG	1	0.75000	100.00000	C	DOUBLE BEVEL GROOVE
124	MIG	1	0.75000	100.00000	C	DOUBLE U GROOVE
125	MIG	1	0.75000	100.00000	C	DOUBLE J GROOVE
126	MIG	1	0.75000	100.00000	A2	SINGLE V GROOVE
127	MIG	1	0.75000	100.00000	A2	SINGLE BEVEL GROOVE
128	MIG	3	0.00000	0.50000	A2	SINGLE BEVEL GROOVE
129	MIG	3	0.00000	0.50000	A2	SINGLE BEVEL GROOVE
130	MIG	3	0.00000	0.50000	B	SINGLE BEVEL GROOVE
131	MIG	3	0.00000	0.50000	B	SINGLE J GROOVE
132	MIG	3	0.00000	0.50000	A1	SINGLE J GROOVE
133	MIG	3	0.00000	0.50000	A1	SINGLE BEVEL GROOVE
134	MIG	3	0.50000	100.00000	C	DOUBLE BEVEL GROOVE
135	MIG	3	0.50000	100.00000	C	DOUBLE J GROOVE
136	MIG	4	0.00000	0.12500	A1	SQUARE GROOVE
137	MIG	4	0.00000	0.12500	B	SQUARE GROOVE
138	MIG	4	0.12500	0.25000	A2	SQUARE GROOVE

139	MIG	4	0.12500	0.25000	B	SQUARE GROOVE
140	MIG	4	0.25000	0.37500	A2	SINGLE V GROOVE
141	MIG	4	0.25000	0.37500	B	SINGLE V GROOVE
142	MIG	4	0.25000	0.37500	B	SINGLE BEVEL GROOVE
143	MIG	4	0.25000	0.37500	A2	SINGLE BEVEL GROOVE
144	MIG	4	0.37500	0.50000	A2	SINGLE BEVEL GROOVE
145	MIG	4	0.37500	0.50000	A2	SINGLE V GROOVE
146	MIG	4	0.37500	0.50000	B	SINGLE V GROOVE
147	MIG	4	0.37500	0.50000	B	SINGLE BEVEL GROOVE
148	MIG	4	0.37500	0.50000	B	SINGLE U GROOVE
149	MIG	4	0.37500	0.50000	B	SINGLE J GROOVE
150	MIG	4	0.50000	0.75000	A2	SINGLE V GROOVE
151	MIG	4	0.50000	0.75000	A2	SINGLE BEVEL GROOVE
152	XYZ	4	0.50000	0.75000	B	SINGLE V GROOVE
153	MIG	4	0.50000	0.75000	B	SINGLE V GROOVE
154	MIG	4	0.50000	0.75000	B	SINGLE BEVEL GROOVE
155	MIG	4	0.50000	0.75000	B	SINGLE U GROOVE
156	MIG	4	0.50000	0.75000	B	SINGLE J GROOVE
157	MIG	4	0.75000	100.00000	C	DOUBLE V GROOVE
158	MIG	4	0.75000	100.00000	C	DOUBLE BEVEL GROOVE
159	MIG	4	0.75000	100.00000	C	DOUBLE U GROOVE
160	MIG	4	0.75000	100.00000	C	DOUBLE J GROOVE
161	MIG	4	0.75000	100.00000	A2	SINGLE V GROOVE
162	MIG	4	0.75000	100.00000	A2	SINGLE BEVEL GROOVE
163	MIG	5	0.00000	0.50000	A1	NOT SPECIFIC.JOBS MACHINED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
164	MIG	5	0.50000	100.00000	A1	NOT SPECIFIC.JOBS MACHINED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
165	PAW	1	0.00000	0.06250	A2	SQUARE GROOVE
166	PAW	1	0.00000	0.06250	B	SQUARE GROOVE
167	PAW	1	0.06250	100.00000	N	KEY-HOLE TECHNIQUE , NO PREPERATION
168	PAW	3	0.00000	0.06250	A2	SINGLE BEVEL GROOVE
169	PAW	3	0.00000	0.06250	B	SINGLE BEVEL GROOVE
170	PAW	3	0.00000	0.06250	B	SINGLE J GROOVE
171	PAW	3	0.00000	0.06250	A1	SINGLE J GROOVE
172	PAW	3	0.00000	0.06250	A1	SINGLE BEVEL GROOVE
173	PAW	3	0.06250	100.00000	N	KEY-HOLE TECHNIQUE , NO PREPERATION

174	PAW	4	0.00000	0.06250 A2	SQUARE GROOVE
175	PAW	4	0.00000	0.06250 B	SQUARE GROOVE
176	PAW	4	0.06250	100.00000 N	KEY-HOLE TECHNIQUE , NO PREPERATION
177	PAW	5	0.00000	0.06250 A1	NOT SPECIFIC, JOBS MACHINED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
178	PAW	5	0.06250	100.00000 N	KEY-HOLE TECHNIQUE , NO PREPERATION
179	SAW	1	0.06250	0.12500 A2	SQUARE GROOVE
180	SAW	1	0.12500	0.18750 A2	SQUARE GROOVE
181	SAW	1	0.12500	0.18750 B	SQUARE GROOVE
182	SAW	1	0.18750	0.25000 B	SQUARE GROOVE
183	SAW	1	0.18750	0.25000 A2	SQUARE GROOVE
184	SAW	1	0.25000	0.31250 A3	SQUARE GROOVE
185	SAW	1	0.25000	0.31250 A3	SINGLE V GROOVE
186	SAW	1	0.25000	0.31250 B	SQUARE GROOVE
187	SAW	1	0.25000	0.31250 B	SINGLE V GROOVE
188	SAW	1	0.25000	0.31250 A4	SINGLE V GROOVE
189	SAW	1	0.31250	0.37500 A3	SQUARE GROOVE
190	SAW	1	0.31250	0.37500 A3	SINGLE V GROOVE
191	SAW	1	0.31250	0.37500 A4	SINGLE V GROOVE
192	SAW	1	0.31250	0.37500 B	SQUARE GROOVE
193	SAW	1	0.31250	0.37500 B	SINGLE V GROOVE
194	SAW	1	0.37500	0.62500 A3	SINGLE V GROOVE
195	SAW	1	0.37500	0.62500 A4	SINGLE V GROOVE
196	SAW	1	0.37500	0.62500 B	SQUARE GROOVE
197	SAW	1	0.37500	0.62500 B	SINGLE V GROOVE
198	SAW	1	0.62500	0.75000 A3	SINGLE V GROOVE
199	SAW	1	0.62500	0.75000 A4	SINGLE V GROOVE
200	SAW	1	0.62500	0.75000 B	SINGLE V GROOVE
201	SAW	1	0.75000	1.50000 A3	SINGLE V GROOVE
202	SAW	1	0.75000	1.50000 A4	SINGLE V GROOVE
203	SAW	1	0.75000	1.50000 B	SINGLE V GROOVE
204	SAW	1	0.75000	1.50000 CB	DOUBLE V GROOVE
205	SAW	1	0.75000	1.50000 C	DOUBLE U GROOVE

206	SAW	1	0.75000	1.50000 C4	DOUBLE V GROOVE
207	SAW	1	1.50000	100.00000 C3	DOUBLE V GROOVE
208	SAW	1	1.50000	100.00000 C3	DOUBLE U GROOVE
209	SAW	1	1.50000	100.00000 C4	DOUBLE U GROOVE
210	SAW	1	1.50000	100.00000 C4	DOUBLE V GROOVE
211	SAW	3	0.00000	0.62500 B	SQUARE GROOVE
212	SAW	3	0.00000	0.62500 C	DOUBLE BEVEL GROOVE
213	SAW	3	0.00000	0.62500 C	DOUBLE BEVEL GROOVE
214	SAW	4	0.06250	0.12500 A2	SQUARE GROOVE
215	SAW	4	0.12500	0.18750 A2	SQUARE GROOVE
216	SAW	4	0.12500	0.18750 B	SQUARE GROOVE
217	SAW	4	0.18750	0.25000 A2	SQUARE GROOVE
218	SAW	4	0.18750	0.25000 B	SQUARE GROOVE
219	SAW	4	0.25000	0.31250 A3	SQUARE GROOVE
220	SAW	4	0.25000	0.31250 A3	SINGLE V GROOVE
221	SAW	4	0.25000	0.31250 B	SQUARE GROOVE
222	SAW	4	0.25000	0.31250 B	SINGLE V GROOVE
223	SAW	4	0.25000	0.31250 A4	SINGLE V GROOVE
224	SAW	4	0.31250	0.37500 A3	SINGLE V GROOVE
225	SAW	4	0.31250	0.37500 A3	SQUARE GROOVE
226	SAW	4	0.31250	0.37500 A4	SINGLE V GROOVE
227	SAW	4	0.31250	0.37500 B	SINGLE V GROOVE
228	SAW	4	0.31250	0.37500 B	SQUARE GROOVE
229	SAW	4	0.37500	0.62500 A3	SINGLE V GROOVE
230	SAW	4	0.37500	0.62500 A4	SINGLE V GROOVE
231	SAW	4	0.37500	0.62500 B	SINGLE V GROOVE
232	SAW	4	0.37500	0.62500 B	SQUARE GROOVE
233	SAW	4	0.62500	0.75000 A3	SINGLE V GROOVE
234	SAW	4	0.62500	0.75000 A4	SINGLE V GROOVE
235	SAW	4	0.62500	0.75000 B	SINGLE V GROOVE
236	SAW	4	0.75000	1.50000 A3	SINGLE V GROOVE
237	SAW	4	0.75000	1.50000 A4	SINGLE V GROOVE
238	SAW	4	0.75000	1.50000 B	SINGLE V GROOVE
239	SAW	4	0.75000	1.50000 C3	DOUBLE V GROOVE
240	SAW	4	0.75000	1.50000 C4	DOUBLE V GROOVE
241	SAW	4	0.75000	1.50000 C	DOUBLE U GROOVE

242	SAW	4	0.75000	1.50000	C	DOUBLE J GROOVE
243	SAW	4	1.50000	100.00000	C3	DOUBLE V GROOVE
244	SAW	4	1.50000	100.00000	C3	DOUBLE U GROOVE
245	SAW	4	1.50000	100.00000	C3	DOUBLE J GROOVE
246	SAW	4	1.50000	100.00000	C4	DOUBLE V GROOVE
247	SAW	4	1.50000	100.00000	C4	DOUBLE U GROOVE
248	SAW	4	1.50000	100.00000	C4	DOUBLE J GROOVE
249	SAW	5	0.00000	0.50000	A1	NOT SPECIFIED,JOBS MACHINED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
250	SAW	5	0.50000	100.00000	A1	NOT SPECIFIED,JOBS MACHINED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
251	SMAW	1	0.00000	0.12500	A1	SQUARE GROOVE
252	SMAW	1	0.00000	0.12500	B	SQUARE GROOVE
253	SMAW	1	0.12500	0.25000	A2	SQUARE GROOVE
254	SMAW	1	0.12500	0.25000	B	SQUARE GROOVE
255	SMAW	1	0.25000	0.37500	A2	SINGLE V GROOVE
256	SMAW	1	0.25000	0.37500	B	SINGLE V GROOVE
257	SMAW	1	0.25000	0.37500	B	SINGLE BEVEL GROOVE
258	SMAW	1	0.25000	0.37500	A2	SINGLE BEVEL GROOVE
259	SMAW	1	0.37500	0.50000	A2	SINGLE BEVEL GROOVE
260	SMAW	1	0.37500	0.50000	A2	SINGLE V GROOVE
261	SMAW	1	0.37500	0.50000	B	SINGLE V GROOVE
262	SMAW	1	0.37500	0.50000	B	SINGLE BEVEL GROOVE
263	SMAW	1	0.37500	0.50000	B	SINGLE U GROOVE
264	SMAW	1	0.37500	0.50000	B	SINGLE J GROOVE
265	SMAW	1	0.50000	0.75000	A2	SINGLE V GROOVE
266	SMAW	1	0.50000	0.75000	A2	SINGLE BEVEL GROOVE
267	XYZ	1	0.50000	0.75000	B	SINGLE V GROOVE
268	SMAW	1	0.50000	0.75000	B	SINGLE BEVEL GROOVE
269	SMAW	1	0.50000	0.75000	B	SINGLE V GROOVE
270	SMAW	1	0.50000	0.75000	B	SINGLE U GROOVE
271	SMAW	1	0.50000	0.75000	B	SINGLE J GROOVE
272	SMAW	1	0.75000	100.00000	C	DOUBLE V GROOVE
273	SMAW	1	0.75000	100.00000	C	DOUBLE BEVEL GROOVE
274	SMAW	1	0.75000	100.00000	C	DOUBLE U GROOVE
275	SMAW	1	0.75000	100.00000	C	DOUBLE J GROOVE
276	SMAW	1	0.75000	100.00000	A2	SINGLE V GROOVE

277	SMAW	1	0.75000	100.00000	A2	SINGLE BEVEL GROOVE
278	SMAW	3	0.00000	0.50000	A2	SINGLE BEVEL GROOVE
279	SMAW	3	0.00000	0.50000	A2	SINGLE BEVEL GROOVE
280	SMAW	3	0.00000	0.50000	B	SINGLE BEVEL GROOVE
281	SMAW	3	0.00000	0.50000	B	SINGLE J GROOVE
282	SMAW	3	0.00000	0.50000	A1	SINGLE J GROOVE
283	SMAW	3	0.00000	0.50000	A1	SINGLE BEVEL GROOVE
284	SMAW	3	0.50000	100.00000	C	DOUBLE BEVEL GROOVE
285	SMAW	3	0.50000	100.00000	C	DOUBLE J GROOVE
286	SMAW	4	0.00000	0.12500	A1	SQUARE GROOVE
287	SMAW	4	0.00000	0.12500	B	SQUARE GROOVE
288	SMAW	4	0.12500	0.25000	A2	SQUARE GROOVE
289	SMAW	4	0.12500	0.25000	B	SQUARE GROOVE
290	SMAW	4	0.25000	0.37500	A2	SINGLE V GROOVE
291	SMAW	4	0.25000	0.37500	B	SINGLE V GROOVE
292	SMAW	4	0.25000	0.37500	B	SINGLE BEVEL GROOVE
293	SMAW	4	0.25000	0.37500	A2	SINGLE BEVEL GROOVE
294	SMAW	4	0.37500	0.50000	A2	SINGLE BEVEL GROOVE
295	SMAW	4	0.37500	0.50000	A2	SINGLE V GROOVE
296	SMAW	4	0.37500	0.50000	B	SINGLE V GROOVE
297	SMAW	4	0.37500	0.50000	B	SINGLE BEVEL GROOVE
298	SMAW	4	0.37500	0.50000	B	SINGLE U GROOVE
299	SMAW	4	0.37500	0.50000	B	SINGLE J GROOVE
300	SMAW	4	0.50000	0.75000	A2	SINGLE V GROOVE
301	SMAW	4	0.50000	0.75000	A2	SINGLE BEVEL GROOVE
302	XYZ	4	0.50000	0.75000	B	SINGLE V GROOVE
303	SMAW	4	0.50000	0.75000	B	SINGLE V GROOVE
304	SMAW	4	0.50000	0.75000	B	SINGLE BEVEL GROOVE
305	SMAW	4	0.50000	0.75000	B	SINGLE U GROOVE
306	SMAW	4	0.50000	0.75000	B	SINGLE J GROOVE
307	SMAW	4	0.75000	100.00000	C	DOUBLE V GROOVE
308	SMAW	4	0.75000	100.00000	C	DOUBLE BEVEL GROOVE
309	SMAW	4	0.75000	100.00000	C	DOUBLE U GROOVE
310	SMAW	4	0.75000	100.00000	C	DOUBLE J GROOVE
311	SMAW	4	0.75000	100.00000	A2	SINGLE V GROOVE

312	SMAW	4	0.75000	100.00000	A2	SINGLE BEVEL GROOVE
313	SMAW	5	0.00000	0.50000	A1	NOT SPECIFIC,JOBS MACHINED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
314	SMAW	5	0.50000	100.00000	A1	NOT SPECIFIC,JOBS MACHINED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
315	TIG	1	0.00000	0.12500	A1	SQUARE GROOVE
316	TIG	1	0.00000	0.12500	B	SQUARE GROOVE
317	TIG	1	0.12500	0.25000	A2	SQUARE GROOVE
318	TIG	1	0.12500	0.25000	B	SQUARE GROOVE
319	TIG	1	0.25000	0.37500	A2	SINGLE V GROOVE
320	TIG	1	0.25000	0.37500	B	SINGLE V GROOVE
321	TIG	1	0.25000	0.37500	B	SINGLE BEVEL GROOVE
322	TIG	1	0.25000	0.37500	A2	SINGLE BEVEL GROOVE
323	TIG	1	0.37500	0.50000	A2	SINGLE BEVEL GROOVE
324	TIG	1	0.37500	0.50000	A2	SINGLE V GROOVE
325	TIG	1	0.37500	0.50000	B	SINGLE V GROOVE
326	TIG	1	0.37500	0.50000	B	SINGLE BEVEL GROOVE
327	TIG	1	0.37500	0.50000	B	SINGLE U GROOVE
328	TIG	1	0.37500	0.50000	B	SINGLE J GROOVE
329	TIG	1	0.50000	0.75000	A2	SINGLE V GROOVE
330	TIG	1	0.50000	0.75000	A2	SINGLE BEVEL GROOVE
331	XYZ	1	0.50000	0.75000	B	SINGLE V GROOVE
332	TIG	1	0.50000	0.75000	B	SINGLE V GROOVE
333	TIG	1	0.50000	0.75000	B	SINGLE BEVEL GROOVE
334	TIG	1	0.50000	0.75000	B	SINGLE U GROOVE
335	TIG	1	0.50000	0.75000	B	SINGLE J GROOVE
336	TIG	1	0.75000	100.00000	C	DOUBLE V GROOVE
337	TIG	1	0.75000	100.00000	C	DOUBLE BEVEL GROOVE
338	TIG	1	0.75000	100.00000	C	DOUBLE U GROOVE
339	TIG	1	0.75000	100.00000	C	DOUBLE J GROOVE
340	TIG	1	0.75000	100.00000	A2	SINGLE V GROOVE
341	TIG	1	0.75000	100.00000	A2	SINGLE BEVEL GROOVE
342	TIG	3	0.00000	0.50000	A2	SINGLE BEVEL GROOVE
343	TIG	3	0.00000	0.50000	A2	SINGLE BEVEL GROOVE
344	TIG	3	0.00000	0.50000	B	SINGLE BEVEL GROOVE
345	TIG	3	0.00000	0.50000	B	SINGLE J GROOVE
346	TIG	3	0.00000	0.50000	A1	SINGLE J GROOVE
347	TIG	3	0.00000	0.50000	A1	SINGLE BEVEL GROOVE

348	TIG	3	0.50000	100.00000	C	DOUBLE BEVEL GROOVE
349	TIG	3	0.50000	100.00000	C	DOUBLE J GROOVE
350	TIG	4	0.00000	0.12500	A1	SQUARE GROOVE
351	TIG	4	0.00000	0.12500	B	SQUARE GROOVE
352	TIG	4	0.12500	0.25000	A2	SQUARE GROOVE
353	TIG	4	0.12500	0.25000	B	SQUARE GROOVE
354	TIG	4	0.25000	0.37500	A2	SINGLE V GROOVE
355	TIG	4	0.25000	0.37500	B	SINGLE V GROOVE
356	TIG	4	0.25000	0.37500	B	SINGLE BEVEL GROOVE
357	TIG	4	0.25000	0.37500	A2	SINGLE BEVEL GROOVE
358	TIG	4	0.37500	0.50000	A2	SINGLE BEVEL GROOVE
359	TIG	4	0.37500	0.50000	A2	SINGLE V GROOVE
360	TIG	4	0.37500	0.50000	B	SINGLE V GROOVE
361	TIG	4	0.37500	0.50000	B	SINGLE BEVEL GROOVE
362	TIG	4	0.37500	0.50000	B	SINGLE U GROOVE
363	TIG	4	0.37500	0.50000	B	SINGLE J GROOVE
364	TIG	4	0.50000	0.75000	A2	SINGLE V GROOVE
365	TIG	4	0.50000	0.75000	A2	SINGLE BEVEL GROOVE
366	XYZ	4	0.50000	0.75000	B	SINGLE V GROOVE
367	TIG	4	0.50000	0.75000	B	SINGLE V GROOVE
368	TIG	4	0.50000	0.75000	B	SINGLE BEVEL GROOVE
369	TIG	4	0.50000	0.75000	B	SINGLE U GROOVE
370	TIG	4	0.50000	0.75000	B	SINGLE J GROOVE
371	TIG	4	0.75000	100.00000	C	DOUBLE V GROOVE
372	TIG	4	0.75000	100.00000	C	DOUBLE BEVEL GROOVE
373	TIG	4	0.75000	100.00000	C	DOUBLE U GROOVE
374	TIG	4	0.75000	100.00000	C	DOUBLE J GROOVE
375	TIG	4	0.75000	100.00000	A2	SINGLE V GROOVE
376	TIG	4	0.75000	100.00000	A2	SINGLE BEVEL GROOVE
377	TIG	5	0.00000	0.50000	A1	NOT SPECIFIC,JOBS MACHINED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
378	TIG	5	0.50000	100.00000	A1	NOT SPECIFIC,JOBS MACHINED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
379	BRAZING	1	0.00000	100.00000	A1	SQUARE GROOVE (RARELY USED)
380	BRAZING	1	0.00000	100.00000	B	SQUARE GROOVE (RARELY USED)
381	BRAZING	3	0.00000	100.00000	A1	SQUARE GROOVE (RARELY USED)
382	BRAZING	3	0.00000	100.00000	B	SQUARE GROOVE (RARELY USED)
383	BRAZING	4	0.00000	100.00000	A1	SQUARE GROOVE (RARELY USED)

384	BRAZING	4	0.00000	100.00000	B	SQUARE GROOVE (RARELY USED)
385	BRAZING	5	0.00000	100.00000	A1	SQUARE GROOVE (RARELY USED)
386	BRAZING	5	0.00000	100.00000	B	SQUARE GROOVE (RARELY USED)
387	SOLDERING	1	0.00000	100.00000	A1	SQUARE GROOVE (RARELY USED)
388	SOLDERING	1	0.00000	100.00000	B	SQUARE GROOVE (RARELY USED)
389	SOLDERING	3	0.00000	100.00000	A1	SQUARE GROOVE (RARELY USED)
390	SOLDERING	3	0.00000	100.00000	B	SQUARE GROOVE (RARELY USED)
391	SOLDERING	4	0.00000	100.00000	A1	SQUARE GROOVE (RARELY USED)
392	SOLDERING	4	0.00000	100.00000	B	SQUARE GROOVE (RARELY USED)
393	SOLDERING	5	0.00000	100.00000	A1	SQUARE GROOVE (RARELY USED)
394	SOLDERING	5	0.00000	100.00000	B	SQUARE GROOVE (RARELY USED)
395	EBW	1	0.00000	0.50000	A1	SQUARE GROOVE
396	EBW	1	0.00000	0.50000	B	SQUARE GROOVE
397	EBW	1	0.50000	100.00000	A1	SQUARE GROOVE
398	EBW	1	0.50000	100.00000	B	SQUARE GROOVE
399	EBW	3	0.00000	0.50000	A1	SQUARE GROOVE
400	EBW	3	0.00000	0.50000	B	SQUARE GROOVE
401	EBW	3	0.50000	100.00000	A1	SQUARE GROOVE
402	EBW	3	0.50000	100.00000	B	SQUARE GROOVE
403	EBW	4	0.00000	0.50000	A1	SQUARE GROOVE
404	EBW	4	0.00000	0.50000	B	SQUARE GROOVE
405	EBW	4	0.50000	100.00000	A1	SQUARE GROOVE
406	EBW	4	0.50000	100.00000	B	SQUARE GROOVE
407	EBW	5	0.00000	0.50000	A1	SQUARE GROOVE
408	EBW	5	0.00000	0.50000	B	SQUARE GROOVE
409	EBW	5	0.50000	100.00000	A1	SQUARE GROOVE
410	EBW	5	0.50000	100.00000	B	SQUARE GROOVE
411	LBW	1	0.00000	0.50000	A1	SQUARE GROOVE
412	LBW	1	0.00000	0.50000	B	SQUARE GROOVE
413	LBW	1	0.50000	100.00000	A1	SQUARE GROOVE
414	LBW	1	0.50000	100.00000	B	SQUARE GROOVE
415	LBW	3	0.00000	0.50000	A1	SQUARE GROOVE
416	LBW	3	0.00000	0.50000	B	SQUARE GROOVE
417	LBW	3	0.50000	100.00000	A1	SQUARE GROOVE
418	LBW	3	0.50000	100.00000	B	SQUARE GROOVE
419	LBW	4	0.00000	0.50000	A1	SQUARE GROOVE

420	LBW	4	0.00000	0.50000	B	SQUARE GROOVE
421	LBW	4	0.50000	100.00000	A1	SQUARE GROOVE
422	LBW	4	0.50000	100.00000	B	SQUARE GROOVE
423	LBW	5	0.00000	0.50000	A1	SQUARE GROOVE
424	LBW	5	0.00000	0.50000	B	SQUARE GROOVE
425	LBW	5	0.50000	100.00000	A1	SQUARE GROOVE
426	LBW	5	0.50000	100.00000	B	SQUARE GROOVE
427	DFW	1	0.00000	100.00000	N	NO PREPERATION NEEDED
428	DFW	3	0.00000	100.00000	N	NO PREPERATION NEEDED
429	DFW	4	0.00000	100.00000	N	NO PREPERATION NEEDED
430	DFW	5	0.00000	100.00000	N	NO PREPERATION NEEDED
431	EXW	1	0.00000	100.00000	N	NO PREPERATION NEEDED
432	EXW	3	0.00000	100.00000	N	NO PREPERATION NEEDED
433	EXW	4	0.00000	100.00000	N	NO PREPERATION NEEDED
434	EXW	5	0.00000	100.00000	N	NO PREPERATION NEEDED
435	USW	1	0.00000	100.00000	N	NO PREPERATION NEEDED
436	USW	3	0.00000	100.00000	N	NO PREPERATION NEEDED
437	USW	4	0.00000	100.00000	N	NO PREPERATION NEEDED
438	USW	5	0.00000	100.00000	N	NO PREPERATION NEEDED
439	FRW	1	0.00000	100.00000	N	PREPERATION FOR SQUARENESS WITHIN 0.01 inch / inch OF JOINT DIAMETER
440	FRW	3	0.00000	100.00000	N	PREPERATION FOR SQUARENESS WITHIN 0.01 inch / inch OF JOINT DIAMETER
441	FRW	4	0.00000	100.00000	N	PREPERATION FOR SQUARENESS WITHIN 0.01 inch / inch OF JOINT DIAMETER
442	FRW	5	0.00000	100.00000	N	PREPERATION FOR SQUARENESS WITHIN 0.01 inch / inch OF JOINT DIAMETER

GRJOIPRE.DBF (Groove Joint design and preparation)
Part-II

Joint name → / Rows ↓	Root face lower (F_lower)	Root face upper (F_upper)	Root gap lower (G_lower)	Root gap upper (G_upper)	Root radius (Radius)	Position (Posi)	Ist lower (Alpha1_low)	Ist upper (Alpha1_hig)	IInd lower (Alpha2_low)	IInd upper (Alpha2_hig)
1	0.00000	0.00000	0.06250	0.06250	0.00000	N	0	0	0	0
2	0.00000	0.00000	0.03125	0.06250	0.00000	N	0	0	0	0
3										
4	0.00000	0.00000	0.06250	0.06250	0.00000	N	0	0	0	0
5	0.00000	0.00000	0.03125	0.06250	0.00000	N	0	0	0	0
6	0.00000	0.00000	0.06250	0.06250	0.00000	B	0	0	0	0
7	0.00000	0.00000	0.03125	0.06250	0.00000	B	0	0	0	0
8	0.00000	0.00000	0.62500	0.75000	0.00000	N	0	0	0	0
9	0.00000	0.00000	0.06250	0.09375	0.00000	Y	0	0	0	0
10	0.00000	0.00000	0.62500	0.75000	0.00000	N	0	0	0	0
11	0.00000	0.06250	0.06250	0.09375	0.00000	Y	0	0	0	0
12	0.00000	0.00000	0.62500	0.75000	0.00000	N	0	0	0	0
13	0.00000	0.12500	0.09375	0.12500	0.00000	Y	0	0	0	0
14	0.00000	0.00000	0.62500	0.75000	0.00000	N	0	0	0	0
15	0.00000	0.06250	0.12500	0.25000	0.00000	Y	0	0	0	0

16	0.00000	0.00000	0.62500	0.75000	0.00000 N	0	0	0
17	0.00000	0.00000	0.06250	0.09375	0.00000 Y	0	0	0
18	0.00000	0.00000	0.62500	0.75000	0.00000 N	0	0	0
19	0.00000	0.06250	0.06250	0.09375	0.00000 Y	0	0	0
20	0.00000	0.00000	0.62500	0.75000	0.00000 N	0	0	0
21	0.00000	0.12500	0.09375	0.12500	0.00000 Y	0	0	0
22	0.00000	0.00000	0.62500	0.75000	0.00000 N	0	0	0
23	0.00000	0.06250	0.12500	0.25000	0.00000 Y	0	0	0
24	0.00000	0.00000	0.00000	0.00000	0.00000 N	0	0	0
25	0.00000	0.00000	0.06250	0.09375	0.00000 B	0	0	0
26	0.00000	0.00000	0.09375	0.15625	0.00000 B	0	0	0
27	0.00000	0.00000	0.87500	0.87500	0.00000 N	0	0	0
28	0.00000	0.00000	1.00000	1.00000	0.00000 N	0	0	0
29	0.00000	0.00000	1.25000	1.25000	0.00000 N	0	0	0
30	0.00000	0.00000	0.87500	0.87500	0.00000 N	0	0	0
31	0.00000	0.00000	1.00000	1.00000	0.00000 N	0	0	0
32	0.00000	0.00000	1.25000	1.25000	0.00000 N	0	0	0
33	0.00000	0.00000	0.00000	0.00000	0.00000 N	0	0	0
34	0.00000	0.00000	0.87500	0.87500	0.00000 B	0	0	0
35	0.00000	0.00000	1.00000	1.00000	0.00000 B	0	0	0
36	0.00000	0.00000	1.25000	1.25000	0.00000 B	0	0	0
37	0.00000	0.00000	0.00000	0.06250	0.00000 N	0	0	0
38	0.00000	0.00000	0.00000	0.00000	0.00000 N	0	0	0
39	0.00000	0.00000	0.06250	0.18750	0.00000 N	0	0	0
40	0.00000	0.00000	0.18750	0.18750	0.00000 N	0	0	0
41	0.00000	0.00000	0.25000	0.37500	0.00000 Y	0	0	0
42	0.00000	0.00000	0.06250	0.09375	0.00000 Y	0	0	0
43	0.00000	0.12500	0.12500	0.25000	0.00000 N	45	50	0
44	0.00000	0.00000	0.25000	0.37500	0.00000 N	45	50	0
45	0.00000	0.00000	0.25000	0.50000	0.00000 N	45	50	45
46	0.00000	0.00000	0.25000	0.50000	0.00000 N	45	50	0
47	0.00000	0.06250	0.06250	0.09375	0.00000 Y	0	0	0
48	0.00000	0.12500	0.12500	0.25000	0.00000 N	45	50	0
49	0.06250	0.18750	0.00000	0.18750	0.25000 N	45	50	45
50	0.06250	0.18750	0.00000	0.18750	0.50000 N	35	50	35
51	0.00000	0.00000	0.25000	0.50000	0.00000 N	45	50	45
52	0.00000	0.00000	0.25000	0.50000	0.00000 N	45	50	0
53	0.00000	0.00000	0.06250	0.12500	0.00000 Y	0	0	0
54	0.00000	0.12500	0.09375	0.12500	0.00000 Y	0	0	0
55	0.00000	0.12500	0.12500	0.25000	0.00000 N	45	50	0
56	0.06250	0.18750	0.00000	0.18750	0.25000 N	45	50	45
57	0.06250	0.18750	0.00000	0.18750	0.50000 N	35	50	35
58	0.00000	0.06250	0.12500	0.25000	0.00000 Y	0	0	0
59	0.00000	0.06250	0.12500	0.25000	0.00000 N	45	45	0
60	0.06250	0.18750	0.00000	0.18750	0.25000 N	45	50	45
61	0.06250	0.18750	0.00000	0.18750	0.50000 N	35	50	35
62	0.00000	0.00000	0.25000	0.50000	0.00000 N	45	50	0
63	0.00000	0.00000	0.25000	0.50000	0.00000 N	45	50	0
64	0.00000	0.06250	0.25000	0.50000	0.00000 N	45	50	0
65	0.00000	0.06250	0.37500	0.50000	0.00000 N	35	50	0
66	0.00000	0.06250	0.12500	0.25000	0.00000 N	45	50	0
67	0.06250	0.12500	0.00000	0.18750	0.50000 N	35	50	35
68	0.06250	0.12500	0.00000	0.18750	0.50000 N	35	50	35
69	0.00000	0.06250	0.12500	0.25000	0.00000 N	45	50	0
70	0.00000	0.06250	0.12500	0.25000	0.00000 N	45	50	0
71	0.06250	0.18750	0.00000	0.18750	0.50000 N	35	50	35
72	0.00000	0.00000	0.00000	0.06250	0.00000 N	0	0	0
73	0.00000	0.00000	0.00000	0.00000	0.00000 N	0	0	0
74	0.00000	0.00000	0.06250	0.18750	0.00000 N	0	0	0
75	0.00000	0.00000	0.18750	0.18750	0.00000 N	0	0	0
76	0.00000	0.00000	0.25000	0.37500	0.00000 Y	0	0	0
77	0.00000	0.00000	0.06250	0.09375	0.00000 Y	0	0	0
78	0.00000	0.12500	0.12500	0.25000	0.00000 N	45	50	0
79	0.00000	0.00000	0.25000	0.37500	0.00000 N	45	50	0
80	0.00000	0.00000	0.25000	0.50000	0.00000 N	45	50	0
81	0.00000	0.00000	0.25000	0.50000	0.00000 N	45	50	45
82	0.00000	0.06250	0.06250	0.09375	0.00000 Y	0	0	0

83	0.00000	0.12500	0.12500	0.25000	0.00000	N	45	50	0	0
84	0.06250	0.18750	0.00000	0.18750	0.25000	N	45	50	45	50
85	0.06250	0.18750	0.00000	0.18750	0.50000	N	35	50	35	50
86	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	45	50
87	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	0	0
88	0.00000	0.00000	0.06250	0.12500	0.00000	Y	0	0	0	0
89	0.00000	0.12500	0.09375	0.12500	0.00000	Y	0	0	0	0
90	0.00000	0.12500	0.12500	0.25000	0.00000	N	45	50	0	0
91	0.06250	0.18750	0.00000	0.18750	0.25000	N	45	50	45	50
92	0.06250	0.18750	0.00000	0.18750	0.50000	N	35	50	35	50
93	0.00000	0.06250	0.12500	0.25000	0.00000	Y	0	0	0	0
94	0.00000	0.06250	0.12500	0.25000	0.00000	N	45	45	0	0
95	0.06250	0.18750	0.00000	0.18750	0.25000	N	45	50	45	50
96	0.06250	0.18750	0.00000	0.18750	0.50000	N	35	50	35	50
97	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	45	50
98	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	0	0
99	0.00000	0.00000	0.06250	0.09375	0.00000	B	0	0	0	0
100	0.00000	0.00000	0.09375	0.15625	0.00000	B	0	0	0	0
101	0.00000	0.00000	0.00000	0.06250	0.00000	N	0	0	0	0
102	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
103	0.00000	0.00000	0.06250	0.18750	0.00000	N	0	0	0	0
104	0.00000	0.00000	0.18750	0.18750	0.00000	N	0	0	0	0
105	0.00000	0.00000	0.12500	0.37500	0.00000	Y	0	0	0	0
106	0.00000	0.00000	0.06250	0.09375	0.00000	Y	0	0	0	0
107	0.00000	0.12500	0.00000	0.12500	0.00000	N	45	50	0	0
108	0.00000	0.00000	0.12500	0.37500	0.00000	N	45	50	0	0
109	0.00000	0.00000	0.12500	0.37500	0.00000	N	45	50	0	0
110	0.00000	0.00000	0.12500	0.37500	0.00000	N	45	50	45	50
111	0.00000	0.06250	0.06251	0.09375	0.00000	Y	0	0	0	0
112	0.00000	0.12500	0.00000	0.12500	0.00000	N	45	50	0	0
113	0.06250	0.18750	0.00000	0.09375	0.25000	N	45	50	45	50
114	0.06250	0.18750	0.00000	0.09375	0.50000	N	35	50	35	50
115	0.00000	0.00000	0.12500	0.37500	0.00000	N	45	50	45	50
116	0.00000	0.00000	0.12500	0.37500	0.00000	N	45	50	0	0
117	0.00000	0.00000	0.06250	0.12500	0.00000	Y	0	0	0	0
118	0.00000	0.12500	0.09375	0.12500	0.00000	Y	0	0	0	0
119	0.00000	0.12500	0.00000	0.12500	0.00000	N	45	50	0	0
120	0.06250	0.18750	0.00000	0.09375	0.25000	N	45	50	45	50
121	0.06250	0.18750	0.00000	0.09375	0.50000	N	35	50	35	50
122	0.00000	0.12500	0.06250	0.12500	0.00000	Y	0	0	0	0
123	0.00000	0.06250	0.00000	0.12500	0.00000	N	45	45	0	0
124	0.06250	0.18750	0.00000	0.09375	0.25000	N	45	50	45	50
125	0.06250	0.18750	0.00000	0.09375	0.50000	N	35	50	35	50
126	0.00000	0.00000	0.12500	0.37500	0.00000	N	45	50	45	50
127	0.00000	0.00000	0.12500	0.37500	0.00000	N	45	50	0	0
128	0.00000	0.06250	0.12500	0.37500	0.00000	N	45	50	0	0
129	0.00000	0.06250	0.25000	0.50000	0.00000	N	35	50	0	0
130	0.00000	0.06250	0.00000	0.12500	0.00000	N	45	50	0	0
131	0.06250	0.12500	0.00000	0.09375	0.50000	N	35	50	35	50
132	0.06250	0.12500	0.00000	0.09375	0.50000	N	35	50	35	50
133	0.00000	0.06250	0.00000	0.12500	0.00000	N	45	50	0	0
134	0.00000	0.06250	0.00000	0.12500	0.00000	N	45	50	0	0
135	0.06250	0.18750	0.00000	0.09375	0.50000	N	35	50	35	50
136	0.00000	0.00000	0.00000	0.06250	0.00000	N	0	0	0	0
137	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
138	0.00000	0.00000	0.06250	0.18750	0.00000	N	0	0	0	0
139	0.00000	0.00000	0.00000	0.18750	0.00000	N	0	0	0	0
140	0.00000	0.00000	0.12500	0.37500	0.00000	Y	0	0	0	0
141	0.00000	0.00000	0.06250	0.09375	0.00000	Y	0	0	0	0
142	0.00000	0.12500	0.00000	0.12525	0.00000	N	45	50	0	0
143	0.00000	0.00000	0.12500	0.37500	0.00000	N	45	50	0	0
144	0.00000	0.00000	0.12500	0.50000	0.00000	N	45	50	0	0
145	0.00000	0.00000	0.12500	0.50000	0.00000	N	45	50	45	50
146	0.00000	0.06250	0.06250	0.09375	0.00000	Y	0	0	0	0
147	0.00000	0.12500	0.00000	0.12500	0.00000	N	45	50	0	0
148	0.06250	0.18750	0.00000	0.09375	0.25000	N	45	50	45	50
149	0.06250	0.18750	0.00000	0.09375	0.50000	N	35	50	35	50
150	0.00000	0.00000	0.12500	0.25000	0.00000	N	45	50	45	50

51	0.00000	0.00000	0.12500	0.25000	0.00000	N	45	50	0	0
52	0.00000	0.00000	0.06250	0.12500	0.00000	Y	0	0	0	0
53	0.00000	0.12500	0.09375	0.12500	0.00000	Y	0	0	0	0
54	0.00000	0.12500	0.00000	0.12500	0.00000	N	45	50	0	0
55	0.06250	0.18750	0.00000	0.09375	0.25000	N	45	50	45	50
56	0.06250	0.18750	0.00000	0.09375	0.50000	N	35	50	35	50
57	0.00000	0.12500	0.06250	0.12500	0.00000	Y	0	0	0	0
58	0.00000	0.06250	0.00000	0.12500	0.00000	N	45	45	0	0
59	0.06250	0.18500	0.00000	0.09375	0.25000	N	45	50	45	50
60	0.06250	0.18500	0.00000	0.09375	0.50000	N	35	50	35	50
61	0.00000	0.00000	0.12500	0.25000	0.00000	N	45	50	45	50
62	0.00000	0.00000	0.12500	0.25000	0.00000	N	45	45	0	0
63	0.00000	0.00000	0.06250	0.09375	0.00000	B	0	0	0	0
64	0.00000	0.00000	0.09375	0.15625	0.00000	B	0	0	0	0
65	0.00000	0.00000	0.00000	0.06250	0.00000	N	0	0	0	0
66	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
67	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
68	0.00000	0.06250	0.25000	0.00000	0.00000	N	45	50	0	0
69	0.00000	0.06250	0.12500	0.25000	0.00000	N	45	50	0	0
70	0.06250	0.12500	0.00000	0.18750	0.50000	N	35	50	35	50
71	0.06250	0.12500	0.00000	0.18750	0.50000	N	35	50	35	50
72	0.00000	0.06250	0.12500	0.25000	0.00000	N	45	50	0	0
73	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
74	0.00000	0.00000	0.00000	0.06250	0.00000	N	0	0	0	0
75	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
76	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
77	0.00000	0.00000	0.06250	0.09375	0.00000	B	0	0	0	0
78	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
79	0.00000	0.00000	0.00000	0.03125	0.00000	N	0	0	0	0
80	0.00000	0.00000	0.00000	0.06250	0.00000	N	0	0	0	0
81	0.00000	0.00000	0.00000	0.03125	0.00000	N	0	0	0	0
82	0.00000	0.00000	0.00000	0.03125	0.00000	N	0	0	0	0
83	0.00000	0.00000	0.00000	0.12500	0.00000	N	0	0	0	0
84	0.00000	0.00000	0.00000	0.12500	0.00000	N	45	100	45	100
85	0.00000	0.00000	0.12500	0.31250	0.00000	N	0	0	0	0
86	0.00000	0.00000	0.00000	0.03125	0.00000	N	45	100	45	100
87	0.12500	0.37500	0.00000	0.03125	0.00000	N	45	100	5	15
88	0.00000	0.00000	0.25000	0.25000	0.00000	C	0	0	0	0
89	0.00000	0.00000	0.12500	0.37500	0.00000	N	45	100	45	100
90	0.00000	0.00000	0.12500	0.37500	0.00000	N	45	100	5	15
91	0.00000	0.00000	0.25000	0.25000	0.00000	N	0	0	0	0
92	0.00000	0.00000	0.00000	0.03125	0.00000	N	45	100	45	100
93	0.12500	0.37500	0.00000	0.03125	0.00000	N	30	100	30	100
94	0.00000	0.00000	0.18750	0.62500	0.00000	N	45	100	5	15
95	0.00000	0.00000	0.25000	0.25000	0.00000	N	0	0	0	0
96	0.00000	0.00000	0.00000	0.03125	0.00000	N	45	100	45	100
97	0.12500	0.37500	0.00000	0.03125	0.00000	N	30	100	30	100
98	0.00000	0.00000	0.18750	0.50000	0.00000	N	45	100	5	15
99	0.00000	0.00000	0.25000	0.25000	0.00000	N	45	100	45	100
200	0.12500	0.37500	0.00000	0.03125	0.00000	N	15	80	15	80
201	0.00000	0.00000	0.62500	1.00000	0.00000	N	45	100	5	15
202	0.00000	0.00000	0.25000	0.25000	0.00000	N	45	100	45	100
203	0.12500	0.37500	0.00000	0.03125	0.00000	N	45	100	45	100
204	0.25000	0.75000	0.00000	0.03125	0.00000	N	5	20	5	20
205	0.25000	0.75000	0.00000	0.03125	0.25000	N	45	100	5	15
206	0.25000	0.75000	0.00000	0.06250	0.00000	N	45	100	45	100
207	0.25000	0.75000	0.00000	0.03125	0.00000	N	5	20	5	20
208	0.25000	0.75000	0.00000	0.03125	0.25000	N	5	20	5	20
209	0.25000	0.75000	0.00000	0.03125	0.25000	N	45	100	5	15
210	0.25000	0.75000	0.00000	0.06250	0.00000	N	0	0	0	0
211	0.00000	0.00000	0.00000	0.03125	0.00000	N	45	45	0	0
212	0.00000	0.06250	0.12500	0.18750	0.00000	N	60	60	0	0
213	0.25000	0.43750	0.00000	0.03125	0.00000	N	0	0	0	0
214	0.00000	0.00000	0.00000	0.03125	0.00000	N	0	0	0	0
215	0.00000	0.00000	0.00000	0.06250	0.00000	N	0	0	0	0
216	0.00000	0.00000	0.00000	0.03125	0.00000	N	0	0	0	0
217	0.00000	0.00000	0.00000	0.12500	0.00000	N				

218	0.00000	0.00000	0.00000	0.03125	0.00000	N	0	0	0
219	0.00000	0.00000	0.00000	0.12500	0.00000	N	0	0	0
220	0.00000	0.00000	0.12500	0.31250	0.00000	N	45	100	45
221	0.00000	0.00000	0.00000	0.03125	0.00000	N	0	0	0
222	0.12500	0.37500	0.00000	0.03125	0.00000	N	45	100	45
223	0.00000	0.00000	0.25000	0.25000	0.00000	N	45	100	5
224	0.00000	0.00000	0.12500	0.37500	0.00000	N	45	100	45
225	0.00000	0.00000	0.12500	0.37500	0.00000	N	0	0	0
226	0.00000	0.00000	0.25000	0.25000	0.00000	N	45	100	5
227	0.12500	0.37500	0.00000	0.03125	0.00000	N	45	100	45
228	0.00000	0.00000	0.00000	0.03125	0.00000	N	0	0	0
229	0.00000	0.00000	0.18750	0.62500	0.00000	N	30	100	30
230	0.00000	0.00000	0.25000	0.25000	0.00000	N	45	100	5
231	0.12500	0.25000	0.00000	0.03125	0.00000	N	45	100	45
232	0.00000	0.00000	0.00000	0.03125	0.00000	N	0	0	0
233	0.00000	0.00000	0.18750	0.75000	0.00000	N	30	100	30
234	0.00000	0.00000	0.25000	0.25000	0.00000	N	45	100	5
235	0.12500	0.25000	0.00000	0.03125	0.00000	N	45	100	45
236	0.00000	0.00000	0.62500	1.00000	0.00000	N	15	80	15
237	0.00000	0.00000	0.25000	0.25000	0.00000	N	45	100	5
238	0.12500	0.25000	0.00000	0.03125	0.00000	N	45	100	45
239	0.25000	0.75000	0.00000	0.03125	0.00000	N	45	100	45
240	0.25000	0.75000	0.00000	0.06250	0.00000	N	45	100	5
241	0.25000	0.75000	0.00000	0.03125	0.25000	N	5	20	5
242	0.25000	0.75000	0.00000	0.03125	0.25000	N	5	20	5
243	0.25000	0.75000	0.00000	0.03125	0.00000	N	45	100	45
244	0.25000	0.75000	0.00000	0.03125	0.25000	N	5	20	5
245	0.25000	0.75000	0.00000	0.03125	0.25000	N	5	20	5
246	0.25000	0.75000	0.00000	0.06250	0.00000	N	45	100	5
247	0.25000	0.75000	0.00000	0.03125	0.25000	N	5	20	5
248	0.25000	0.75000	0.00000	0.03125	0.25000	N	5	20	5
249	0.00000	0.00000	0.06250	0.09375	0.00000	B	0	0	0
250	0.00000	0.00000	0.09375	0.15625	0.00000	B	0	0	0
251	0.00000	0.00000	0.00000	0.06250	0.00000	N	0	0	0
252	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0
253	0.00000	0.00000	0.06250	0.18750	0.00000	N	0	0	0
254	0.00000	0.00000	0.18750	0.18750	0.00000	N	0	0	0
255	0.00000	0.00000	0.25000	0.37500	0.00000	Y	0	0	0
256	0.00000	0.00000	0.06250	0.09375	0.00000	Y	0	0	0
257	0.00000	0.12500	0.12500	0.25000	0.00000	N	45	50	0
258	0.00000	0.00000	0.25000	0.37500	0.00000	N	45	50	0
259	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	0
260	0.00000	0.00000	0.25000	0.50000	0.00000	Y	45	50	45
261	0.00000	0.06250	0.06250	0.09375	0.00000	N	0	0	0
262	0.00000	0.12500	0.12500	0.25000	0.00000	N	45	50	0
263	0.06250	0.18750	0.00000	0.18750	0.25000	N	45	50	45
264	0.06250	0.18750	0.00000	0.18750	0.50000	N	35	50	35
265	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	45
266	0.00000	0.00000	0.25000	0.50000	0.00000	Y	45	50	0
267	0.00000	0.00000	0.06250	0.12500	0.00000	N	0	0	0
268	0.00000	0.12500	0.12500	0.25000	0.00000	N	45	50	0
269	0.00000	0.00000	0.09375	0.12500	0.00000	Y	0	0	0
270	0.06250	0.18750	0.00000	0.18750	0.25000	N	45	50	45
271	0.06250	0.18750	0.00000	0.18750	0.50000	N	35	50	35
272	0.00000	0.06250	0.12500	0.25000	0.00000	Y	0	0	0
273	0.00000	0.06250	0.12500	0.25000	0.00000	N	45	45	0
274	0.06250	0.18750	0.00000	0.09375	0.25000	N	45	50	45
275	0.06250	0.18750	0.00000	0.09375	0.50000	N	35	50	35
276	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	45
277	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	0
278	0.00000	0.06250	0.25000	0.50000	0.00000	N	45	50	0
279	0.00000	0.06250	0.37500	0.75000	0.00000	N	35	50	0
280	0.00000	0.06250	0.12500	0.25000	0.00000	N	45	50	0
281	0.06250	0.12500	0.00000	0.18750	0.50000	N	35	50	35
282	0.06250	0.12500	0.00000	0.18750	0.50000	N	35	50	35
283	0.00000	0.06250	0.12500	0.25000	0.00000	N	45	50	0

284	0.00000	0.06250	0.12500	0.25000	0.00000	N	45	50	0	0
285	0.06250	0.18750	0.00000	0.09375	0.50000	N	35	50	35	50
286	0.00000	0.00000	0.00000	0.06250	0.00000	N	0	0	0	0
287	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
288	0.00000	0.00000	0.06250	0.18750	0.00000	N	0	0	0	0
289	0.00000	0.00000	0.18750	0.18750	0.00000	N	0	0	0	0
290	0.00000	0.00000	0.25000	0.50000	0.00000	Y	0	0	0	0
291	0.00000	0.00000	0.06250	0.09375	0.00000	Y	0	0	0	0
292	0.00000	0.12500	0.12500	0.25000	0.00000	N	45	50	0	0
293	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	0	0
294	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	0	0
295	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	45	50
296	0.00000	0.06250	0.06250	0.09375	0.00000	Y	0	0	0	0
297	0.00000	0.12500	0.12500	0.25000	0.00000	N	45	50	0	0
298	0.06250	0.18750	0.00000	0.18750	0.25000	N	45	50	45	50
299	0.06250	0.18750	0.00000	0.18750	0.50000	N	35	50	35	50
300	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	45	50
301	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	0	0
302	0.00000	0.00000	0.06250	0.12500	0.00000	Y	0	0	0	0
303	0.00000	0.12500	0.09375	0.12500	0.00000	Y	0	0	0	0
304	0.00000	0.12500	0.12500	0.25000	0.00000	N	45	50	0	0
305	0.06250	0.18750	0.00000	0.18750	0.25000	N	45	50	45	50
306	0.06250	0.18750	0.00000	0.18750	0.50000	N	35	50	35	50
307	0.00000	0.06250	0.12500	0.25000	0.00000	Y	0	0	0	0
308	0.00000	0.06250	0.12500	0.25000	0.00000	N	45	45	0	0
309	0.06250	0.18750	0.00000	0.18750	0.25000	N	45	50	45	50
310	0.06250	0.18750	0.00000	0.18750	0.50000	N	35	50	35	50
311	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	45	50
312	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	0	0
313	0.00000	0.00000	0.06250	0.09375	0.00000	B	0	0	0	0
314	0.00000	0.00000	0.09375	0.15625	0.00000	B	0	0	0	0
315	0.00000	0.00000	0.00000	0.06250	0.00000	N	0	0	0	0
316	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
317	0.00000	0.00000	0.06250	0.18750	0.00000	N	0	0	0	0
318	0.00000	0.00000	0.18750	0.18750	0.00000	N	0	0	0	0
319	0.00000	0.00000	0.25000	0.37500	0.00000	Y	0	0	0	0
320	0.00000	0.00000	0.06250	0.09375	0.00000	Y	0	0	0	0
321	0.00000	0.12500	0.12500	0.25000	0.00000	N	45	50	0	0
322	0.00000	0.00000	0.25000	0.37500	0.00000	N	45	50	0	0
323	0.00000	0.00000	0.25000	0.37500	0.00000	N	45	50	0	0
324	0.00000	0.00000	0.25000	0.37500	0.00000	N	45	50	45	50
325	0.00000	0.06250	0.06250	0.09375	0.00000	Y	0	0	0	0
326	0.00000	0.12500	0.12500	0.25000	0.00000	N	45	50	0	0
327	0.06250	0.18750	0.00000	0.18750	0.25000	N	45	50	45	50
328	0.06250	0.18750	0.00000	0.18750	0.50000	N	45	50	45	50
329	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	45	50
330	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	0	0
331	0.00000	0.00000	0.06250	0.12500	0.00000	Y	0	0	0	0
332	0.00000	0.12500	0.09375	0.12500	0.00000	Y	0	0	0	0
333	0.00000	0.12500	0.12500	0.25000	0.00000	N	45	50	0	0
334	0.06250	0.18750	0.00000	0.18750	0.25000	N	45	50	45	50
335	0.06250	0.18750	0.00000	0.18750	0.50000	N	35	50	35	50
336	0.00000	0.06250	0.12500	0.25000	0.00000	Y	0	0	0	0
337	0.00000	0.06250	0.12500	0.25000	0.00000	N	45	45	0	0
338	0.06250	0.18750	0.00000	0.18750	0.25000	N	45	50	45	50
339	0.06250	0.18750	0.00000	0.18750	0.50000	N	35	50	35	50
340	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	45	50
341	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	0	0
342	0.00000	0.06250	0.25000	0.50000	0.00000	N	45	50	0	0
343	0.00000	0.06250	0.37500	0.60000	0.00000	N	35	50	0	0

344	0.00000	0.06250	0.12500	0.25000	0.00000	N	45	50	0	0
345	0.06250	0.12500	0.00000	0.18750	0.50000	N	35	50	35	50
346	0.06250	0.12500	0.00000	0.18750	0.50000	N	35	50	35	50
347	0.00000	0.06250	0.12500	0.25000	0.00000	N	45	50	0	0
348	0.00000	0.06250	0.12500	0.25000	0.00000	N	45	50	0	0
349	0.06250	0.18750	0.00000	0.09375	0.50000	N	35	50	35	50
350	0.00000	0.00000	0.00000	0.06250	0.00000	N	0	0	0	0
351	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
352	0.00000	0.00000	0.06250	0.18750	0.00000	N	0	0	0	0
353	0.00000	0.00000	0.18750	0.18750	0.00000	N	0	0	0	0
354	0.00000	0.00000	0.25000	0.37500	0.00000	Y	0	0	0	0
355	0.00000	0.00000	0.06250	0.09375	0.00000	Y	0	0	0	0
356	0.00000	0.12500	0.12500	0.25000	0.00000	N	45	50	0	0
357	0.00000	0.00000	0.25000	0.37500	0.00000	N	45	50	0	0
358	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	0	0
359	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	45	50
360	0.00000	0.06250	0.06250	0.09375	0.00000	Y	0	0	0	0
361	0.00000	0.12500	0.12500	0.25000	0.00000	N	45	50	0	0
362	0.06250	0.18750	0.00000	0.18750	0.25000	N	45	50	45	50
363	0.06250	0.18750	0.00000	0.18750	0.50000	N	35	50	35	50
364	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	45	50
365	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	0	0
366	0.00000	0.00000	0.06250	0.12500	0.00000	Y	0	0	0	0
367	0.00000	0.12500	0.09375	0.12500	0.00000	Y	0	0	0	0
368	0.00000	0.12500	0.12500	0.25000	0.00000	N	45	50	0	0
369	0.06250	0.18750	0.00000	0.18750	0.25000	N	45	50	45	50
370	0.06250	0.18750	0.00000	0.18750	0.50000	N	35	50	35	50
371	0.00000	0.06250	0.12500	0.25000	0.00000	Y	0	0	0	0
372	0.00000	0.06250	0.12500	0.25000	0.00000	N	45	45	0	0
373	0.06250	0.18750	0.00000	0.18750	0.25000	N	45	50	45	50
374	0.06250	0.18750	0.00000	0.18750	0.50000	N	35	50	35	50
375	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	45	50
376	0.00000	0.00000	0.25000	0.50000	0.00000	N	45	50	0	0
377	0.00000	0.00000	0.06250	0.09375	0.00000	B	0	0	0	0
378	0.00000	0.00000	0.09375	0.15625	0.00000	B	0	0	0	0
379	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
380	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
381	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
382	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
383	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
384	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
385	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
386	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
387	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
388	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
389	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
390	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
391	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
392	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
393	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
394	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
395	0.00000	0.00000	0.00300	0.01000	0.00000	N	0	0	0	0
396	0.00000	0.00000	0.00300	0.01000	0.00000	N	0	0	0	0
397	0.00000	0.00000	0.00300	0.03000	0.00000	N	0	0	0	0
398	0.00000	0.00000	0.00300	0.03000	0.00000	N	0	0	0	0
399	0.00000	0.00000	0.00300	0.01000	0.00000	N	0	0	0	0
400	0.00000	0.00000	0.00300	0.01000	0.00000	N	0	0	0	0
401	0.00000	0.00000	0.00300	0.03000	0.00000	N	0	0	0	0
402	0.00000	0.00000	0.00300	0.03000	0.00000	N	0	0	0	0
403	0.00000	0.00000	0.00300	0.01000	0.00000	N	0	0	0	0
404	0.00000	0.00000	0.00300	0.01000	0.00000	N	0	0	0	0
405	0.00000	0.00000	0.00300	0.03000	0.00000	N	0	0	0	0
406	0.00000	0.00000	0.00300	0.03000	0.00000	N	0	0	0	0
407	0.00000	0.00000	0.00300	0.01000	0.00000	N	0	0	0	0
408	0.00000	0.00000	0.00300	0.01000	0.00000	N	0	0	0	0
409	0.00000	0.00000	0.00300	0.03000	0.00000	N	0	0	0	0
410	0.00000	0.00000	0.00300	0.03000	0.00000	N	0	0	0	0
411	0.00000	0.00000	0.00000	0.00400	0.00000	N	0	0	0	0

[illegible]					0.00000	N	0	0	0	0
[illegible]						N	0	0	0	0
[illegible]					0.00000	N	0	0	0	0
[illegible]					0.00000	N	0	0	0	0
[illegible]				0.00400	0.00000	N	0	0	0	0
[illegible]					0.00000	N	0	0	0	0
[illegible]				0.01000	0.00000	N	0	0	0	0
[illegible]					0.00000	N	0	0	0	0
[illegible]					0.00000	N	0	0	0	0
[illegible]				0.00400	0.00000	N	0	0	0	0
[illegible]				0.01000	0.00000	N	0	0	0	0
[illegible]				0.01000	0.00000	N	0	0	0	0
[illegible]				0.00400	0.00000	N	0	0	0	0
[illegible]					0.00000	N	0	0	0	0
[illegible]				0.01000	0.00000	N	0	0	0	0
427	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
428	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
429	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
430	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
431	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
432	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
433	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
434	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
435	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
436	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
437	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
438	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
439	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
440	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
441	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0
442	0.00000	0.00000	0.00000	0.00000	0.00000	N	0	0	0	0

ANGRANG.DBF (Included angle for [illegible])

Fields name → / Records ↓	[illegible] (Alpha_low)	[illegible] (Alpha_hig)	[illegible]	[illegible]
1	45	80	90	100
2	80	135	100	60

VGRANG.DBF (Included angle for V groove joint)

Fields name →	Position code (Posi_code)	[illegible] (Alpha_low)	[illegible] (Alpha_hig)
1	1	60	100
2	2	70	100
3	3	70	100
4	4	80	100
5	5	80	100

EXPECTED DATA (Weight joint design and preparation)

Record #	Process (PROCESS)	Description (DESIGN_CODE)	Lower (WT_LOWER)	Upper (WT_UPPER)	Explanation (EXPLANATION)
1	CAW	1	0.00000	100.00000	SIMPLE FILLET JOINT
2	CAW	2	0.00000	100.00000	SIMPLE FILLET JOINT
3	CAW	3	0.00000	100.00000	SIMPLE FILLET JOINT
4	CAW	4	0.00000	100.00000	CLOSE CORNER JOINT
5	CAW	4	0.00000	100.00000	OPEN CORNER JOINT
6	CAW	4	0.00000	100.00000	PRELAPPED CORNER JOINT
7	CAW	5	0.00000	100.00000	SIMPLE FILLET JOINT,JOBS BEVELLED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
8	EGW	1	0.00000	100.00000	SIMPLE FILLET JOINT
9	EGW	2	0.00000	100.00000	SIMPLE FILLET JOINT
10	EGW	3	0.00000	100.00000	SIMPLE FILLET JOINT
11	EGW	4	0.00000	100.00000	CLOSE CORNER JOINT
12	EGW	4	0.00000	100.00000	OPEN CORNER JOINT
13	EGW	4	0.00000	100.00000	PRELAPPED CORNER JOINT
14	EGW	5	0.00000	100.00000	SIMPLE FILLET JOINT,JOBS BEVELLED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
15	ESW	1	0.00000	100.00000	SIMPLE FILLET JOINT
16	ESW	2	0.00000	100.00000	SIMPLE FILLET JOINT
17	ESW	3	0.00000	100.00000	SIMPLE FILLET JOINT
18	ESW	4	0.00000	100.00000	CLOSE CORNER JOINT
19	ESW	4	0.00000	100.00000	OPEN CORNER JOINT
20	ESW	4	0.00000	100.00000	PRELAPPED CORNER JOINT
21	ESW	5	0.00000	100.00000	SIMPLE FILLET JOINT,JOBS BEVELLED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
22	FCAW	1	0.00000	100.00000	SIMPLE FILLET JOINT
23	FCAW	2	0.00000	100.00000	SIMPLE FILLET JOINT
24	FCAW	3	0.00000	100.00000	SIMPLE FILLET JOINT
25	FCAW	4	0.00000	100.00000	CLOSE CORNER JOINT
26	FCAW	4	0.00000	100.00000	OPEN CORNER JOINT
27	FCAW	4	0.00000	100.00000	PRELAPPED CORNER JOINT
28	FCAW	5	0.00000	100.00000	SIMPLE FILLET JOINT,JOBS BEVELLED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
29	MIG	1	0.00000	100.00000	SIMPLE FILLET JOINT
30	MIG	2	0.00000	100.00000	SIMPLE FILLET JOINT
31	MIG	3	0.00000	100.00000	SIMPLE FILLET JOINT
32	MIG	4	0.00000	100.00000	CLOSE CORNER JOINT
33	MIG	4	0.00000	100.00000	OPEN CORNER JOINT
34	MIG	4	0.00000	100.00000	PRELAPPED CORNER JOINT
35	MIG	5	0.00000	100.00000	SIMPLE FILLET JOINT,JOBS BEVELLED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
36	PAW	1	0.00000	100.00000	SIMPLE FILLET JOINT
37	PAW	2	0.00000	100.00000	SIMPLE FILLET JOINT
38	PAW	3	0.00000	100.00000	SIMPLE FILLET JOINT
39	PAW	4	0.00000	100.00000	CLOSE CORNER JOINT
40	PAW	4	0.00000	100.00000	OPEN CORNER JOINT
41	PAW	4	0.00000	100.00000	PRELAPPED CORNER JOINT
42	PAW	5	0.00000	100.00000	SIMPLE FILLET JOINT,JOBS BEVELLED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
43	SAW	1	0.00000	100.00000	SIMPLE FILLET JOINT
44	SAW	2	0.00000	100.00000	SIMPLE FILLET JOINT
45	SAW	3	0.00000	100.00000	SIMPLE FILLET JOINT
46	SAW	4	0.00000	100.00000	CLOSE CORNER JOINT
47	SAW	4	0.00000	100.00000	OPEN CORNER JOINT
48	SAW	4	0.00000	100.00000	PRELAPPED CORNER JOINT
49	SAW	5	0.00000	100.00000	SIMPLE FILLET JOINT,JOBS BEVELLED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
50	SMAW	1	0.00000	100.00000	SIMPLE FILLET JOINT
51	SMAW	2	0.00000	100.00000	SIMPLE FILLET JOINT
52	SMAW	3	0.00000	100.00000	SIMPLE FILLET JOINT
53	SMAW	5	0.00000	100.00000	SIMPLE FILLET JOINT,JOBS BEVELLED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
54	SMAW	4	0.00000	100.00000	CLOSE CORNER JOINT
55	SMAW	4	0.00000	100.00000	OPEN CORNER JOINT
56	SMAW	4	0.00000	100.00000	PRELAPPED CORNER JOINT
57	TIG	1	0.00000	100.00000	SIMPLE FILLET JOINT
58	TIG	2	0.00000	100.00000	SIMPLE FILLET JOINT
59	TIG	3	0.00000	100.00000	SIMPLE FILLET JOINT
60	TIG	4	0.00000	100.00000	CLOSE CORNER JOINT
61	TIG	4	0.00000	100.00000	OPEN CORNER JOINT
62	TIG	4	0.00000	100.00000	PRELAPPED CORNER JOINT
63	TIG	5	0.00000	100.00000	SIMPLE FILLET JOINT,JOBS BEVELLED TO PROVIDE BETA ANGLE ACCORDING TO ALPHA ANGLE
64	BRAZING	1	0.00000	100.00000	PRELAPPED FILLET JOINT (OVERLAP >= 3 TIMES THE WORKING THICKNESS (WT))
65	BRAZING	2	0.00000	100.00000	PRELAPPED FILLET JOINT (OVERLAP >= 2 TIMES THE WORKING THICKNESS (WT))
66	BRAZING	3	0.00000	100.00000	PRELAPPED FILLET JOINT (OVERLAP >= 1 TIMES THE WORKING THICKNESS (WT))

		4	0.00000	100.00000	PRELAPPED FILLET JOINT (OVERLAP >= 3 TIMES THE WORKING THICKNESS (WT)
		5	0.00000	100.00000	PRELAPPED FILLET JOINT (OVERLAP >= 3 TIMES THE WORKING THICKNESS (WT)
67	BRAZING	1	0.00000	100.00000	PRELAPPED FILLET JOINT (OVERLAP >= 3 TIMES THE WORKING THICKNESS (WT)
68	BRAZING	2	0.00000	100.00000	PRELAPPED FILLET JOINT (OVERLAP >= 3 TIMES THE WORKING THICKNESS (WT)
69	SOLDERING	3	0.00000	100.00000	PRELAPPED FILLET JOINT (OVERLAP >= 3 TIMES THE WORKING THICKNESS (WT)
70	SOLDERING	4	0.00000	100.00000	PRELAPPED FILLET JOINT (OVERLAP >= 3 TIMES THE WORKING THICKNESS (WT)
71	SOLDERING	5	0.00000	100.00000	PRELAPPED FILLET JOINT (OVERLAP >= 3 TIMES THE WORKING THICKNESS (WT)
72	SOLDERING	1	0.00000	100.00000	REQUIRE NO JOINT PREPERATION
73	SOLDERING	2	0.00000	100.00000	REQUIRE NO JOINT PREPERATION
74	DFW	3	0.00000	100.00000	REQUIRE NO JOINT PREPERATION
75	DFW	4	0.00000	100.00000	REQUIRE NO JOINT PREPERATION
76	DFW	5	0.00000	100.00000	REQUIRE NO JOINT PREPERATION
77	DFW	1	0.00000	100.00000	REQUIRE NO JOINT PREPERATION
78	DFW	2	0.00000	100.00000	REQUIRE NO JOINT PREPERATION
79	EXW	3	0.00000	100.00000	REQUIRE NO JOINT PREPERATION
80	EXW	4	0.00000	100.00000	REQUIRE NO JOINT PREPERATION
81	EXW	5	0.00000	100.00000	REQUIRE NO JOINT PREPERATION
82	EXW	1	0.00000	100.00000	REQUIRE NO JOINT PREPERATION
83	EXW	2	0.00000	100.00000	REQUIRE NO JOINT PREPERATION
84	USW	3	0.00000	100.00000	REQUIRE NO JOINT PREPERATION
85	USW	4	0.00000	100.00000	REQUIRE NO JOINT PREPERATION
86	USW	5	0.00000	100.00000	REQUIRE NO JOINT PREPERATION
87	USW	2	0.00000	0.06250	SIMPLE FILLET JOINT
88	USW	2	0.06250	100.00000	FILLET JOINT IS NOT USED
89	EBW	3	0.00000	100.00000	FILLET JOINT IS NOT USED
90	EBW	4	0.00000	100.00000	FILLET JOINT IS NOT USED
91	EBW	5	0.00000	100.00000	FILLET JOINT IS NOT USED
92	EBW	1	0.00000	100.00000	FILLET JOINT IS NOT USED
93	EBW	1	0.00000	100.00000	FILLET JOINT IS NOT USED
94	EBW	2	0.00000	100.00000	FILLET JOINT IS NOT USED
95	FRW	3	0.00000	100.00000	FILLET JOINT IS NOT USED
96	FRW	4	0.00000	100.00000	FILLET JOINT IS NOT USED
97	FRW	5	0.00000	100.00000	FILLET JOINT IS NOT USED
98	FRW	1	0.00000	100.00000	FILLET JOINT IS NOT USED
99	FRW	2	0.00000	100.00000	FILLET JOINT IS NOT USED
100	LBW	3	0.00000	100.00000	FILLET JOINT IS NOT USED
101	LBW	4	0.00000	100.00000	FILLET JOINT IS NOT USED
102	LBW	5	0.00000	100.00000	FILLET JOINT IS NOT USED
103	LBW				
104	LBW				

FJOIPRE.DBF (Fillet joint design and preparation)
PART II

		Root gap (G_lower)	Root gap (G_upper)	Lower overlap (L_lower)	Upper overlap (L_upper)		Outside angle (Beta)
1	1	0.00000	0.18750	0.00000	0.00000	0	0	0
2	1	0.00000	0.18750	0.00000	0.00000	0	0	0
3	1	0.00000	0.18750	0.00000	0.00000	0	0	0
4	2	0.00000	0.00000	0.00000	0.00000	0	0	0
5	1	0.03125	0.09375	0.00000	0.00000	0	0	0
6	1	0.00000	0.00000	0.03125	0.09375	45	135	90
7	1	0.00000	0.00000	0.00000	0.00000	0	0	0
8	1	0.00000	0.18750	0.00000	0.00000	0	0	0
9	1	0.00000	0.18750	0.00000	0.00000	0	0	0
10	1	0.00000	0.18750	0.00000	0.00000	0	0	0
11	2	0.00000	0.00000	0.00000	0.00000	0	0	0
12	1	0.03125	0.09375	0.00000	0.00000	0	0	0
13	1	0.00000	0.00000	0.03125	0.09375	45	135	90
14	1	0.00000	0.00000	0.00000	0.00000	0	0	0
15	1	0.00000	0.18750	0.00000	0.00000	0	0	0
16	1	0.00000	0.18750	0.00000	0.00000	0	0	0
17	1	0.00000	0.18750	0.00000	0.00000	0	0	0
18	2	0.00000	0.00000	0.00000	0.00000	0	0	0
19	1	0.03125	0.09375	0.00000	0.00000	0	0	0
20	1	0.00000	0.00000	0.03125	0.09375	45	135	90
21	1	0.00000	0.00000	0.00000	0.00000	0	0	0
22	1	0.00000	0.18750	0.00000	0.00000	0	0	0
23	1	0.00000	0.18750	0.00000	0.00000	0	0	0
24	1	0.00000	0.18750	0.00000	0.00000	0	0	0
25	2	0.00000	0.00000	0.00000	0.00000	0	0	0
26	1	0.03125	0.09375	0.00000	0.00000	0	0	0

27	1	0.00000	0.00000	0.00000	0.00000	45	135
28	1	0.00000	0.18750	0.00000	0.00000	0	0
29	1	0.00000	0.18750	0.00000	0.00000	0	0
30	1	0.00000	0.18750	0.00000	0.00000	0	0
31	1	0.00000	0.00000	0.00000	0.00000	0	0
32	2	0.03125	0.09375	0.00000	0.00000	0	0
33	1	0.00000	0.00000	0.03125	0.09375	45	135
34	1	0.00000	0.00000	0.00000	0.00000	0	0
35	1	0.00000	0.18750	0.00000	0.00000	0	0
36	1	0.00000	0.18750	0.00000	0.00000	0	0
37	1	0.00000	0.18750	0.00000	0.00000	0	0
38	1	0.00000	0.00000	0.00000	0.00000	0	0
39	2	0.03125	0.09375	0.00000	0.00000	0	0
40	1	0.00000	0.00000	0.03125	0.09375	45	135
41	1	0.00000	0.00000	0.00000	0.00000	0	0
42	1	0.00000	0.18750	0.00000	0.00000	0	0
43	1	0.00000	0.18750	0.00000	0.00000	0	0
44	1	0.00000	0.18750	0.00000	0.00000	0	0
45	1	0.00000	0.00000	0.00000	0.00000	0	0
46	2	0.03125	0.09375	0.00000	0.00000	0	0
47	1	0.00000	0.00000	0.03125	0.09375	45	135
48	1	0.00000	0.00000	0.00000	0.00000	0	0
49	1	0.00000	0.18750	0.00000	0.00000	0	0
50	1	0.00000	0.18750	0.00000	0.00000	0	0
51	1	0.00000	0.18750	0.00000	0.00000	0	0
52	1	0.00000	0.00000	0.00000	0.00000	45	135
53	1	0.00000	0.00000	0.00000	0.00000	0	0
54	2	0.03125	0.09375	0.00000	0.00000	0	0
55	1	0.00000	0.00000	0.03125	0.09375	0	0
56	1	0.00000	0.18750	0.00000	0.00000	0	0
57	1	0.00000	0.18750	0.00000	0.00000	0	0
58	1	0.00000	0.18750	0.00000	0.00000	0	0
59	1	0.00000	0.00000	0.00000	0.00000	0	0
60	2	0.03125	0.09375	0.00000	0.00000	0	0
61	1	0.00000	0.00000	0.03125	0.09375	45	135
62	1	0.00000	0.00000	0.00000	0.00000	0	0
63	1	0.00000	0.00000	0.00000	0.00000	0	0
64	1	0.00000	0.00000	0.00000	0.00000	0	0
65	1	0.00000	0.00000	0.00000	0.00000	0	0
66	1	0.00000	0.00000	0.00000	0.00000	0	0
67	1	0.00000	0.00000	0.00000	0.00000	0	0
68	1	0.00000	0.00000	0.00000	0.00000	0	0
69	1	0.00000	0.00000	0.00000	0.00000	0	0
70	1	0.00000	0.00000	0.00000	0.00000	0	0
71	1	0.00000	0.00000	0.00000	0.00000	0	0
72	1	0.00000	0.00000	0.00000	0.00000	0	0
73	1	0.00000	0.00000	0.00000	0.00000	0	0
74	0	0.00000	0.00000	0.00000	0.00000	0	0
75	0	0.00000	0.00000	0.00000	0.00000	0	0
76	0	0.00000	0.00000	0.00000	0.00000	0	0
77	0	0.00000	0.00000	0.00000	0.00000	0	0
78	0	0.00000	0.00000	0.00000	0.00000	0	0
79	0	0.00000	0.00000	0.00000	0.00000	0	0
80	0	0.00000	0.00000	0.00000	0.00000	0	0
81	0	0.00000	0.00000	0.00000	0.00000	0	0
82	0	0.00000	0.00000	0.00000	0.00000	0	0
83	0	0.00000	0.00000	0.00000	0.00000	0	0
84	0	0.00000	0.00000	0.00000	0.00000	0	0
85	0	0.00000	0.00000	0.00000	0.00000	0	0
86	0	0.00000	0.00000	0.00000	0.00000	0	0
87	0	0.00000	0.00000	0.00000	0.00000	0	0
88	0	0.00000	0.00000	0.00000	0.00000	0	0
89	1	0.00000	0.00000	0.00000	0.00000	0	0
90	1	0.00000	0.00000	0.00000	0.00000	0	0
91	0	0.00000	0.00000	0.00000	0.00000	0	0
92	0	0.00000	0.00000	0.00000	0.00000	0	0
93	0	0.00000	0.00000	0.00000	0.00000	0	0
94	0	0.00000	0.00000	0.00000	0.00000	0	0
95	0	0.00000	0.00000	0.00000	0.00000	0	0
96	0	0.00000	0.00000	0.00000	0.00000	0	0
97	0	0.00000	0.00000	0.00000	0.00000	0	0
98	0	0.00000	0.00000	0.00000	0.00000	0	0

99	0	0.00000	0.00000	0.00000	0.00000	0	0	0
100	0	0.00000	0.00000	0.00000	0.00000	0	0	0
101	0	0.00000	0.00000	0.00000	0.00000	0	0	0
102	0	0.00000	0.00000	0.00000	0.00000	0	0	0
103	0	0.00000	0.00000	0.00000	0.00000	0	0	0
104	0	0.00000	0.00000	0.00000	0.00000	0	0	0

ELECTROD.DBF (consumables and non-consumables electrode specification for some materials)

Fields name → / Records ↓	Process (Proc_name)	Material (Material)	Material (Code)	Filler (Filler_AWS)	Advice (Advice)
1	SMAW	LCS	1	P1	
2	SMAW	MCS	2	P1	
3	SMAW	HCS	3	P1	
4	SMAW	TS	4	P1	
5	SMAW	CS	5	P1	
6	SMAW	AS	8	P1	
7	SMAW	AS	9	P1	
8	SMAW	AS	10	P1	
9	SMAW	AS	11	P1	
10	SMAW	AS	12	P1	
11	SMAW	AS	13	P1	
12	SMAW	AS	14	P1	
13	SMAW	SS	20	E-308	
14	SMAW	SS	21	E-308	
15	SMAW	SS	24	E-308	
16	SMAW	SS	26	E-308	
17	SMAW	SS	27	E-308	
18	SMAW	SS	22	E-309	
19	SMAW	SS	25	E-347	
20	SMAW	SS	25	E-308L	
21	SMAW	SS	23	E-312	
22	SMAW	SS	28	E-309	
23	SMAW	SS	29	E-310	
24	SMAW	SS	30	E-316	
25	SMAW	SS	31	E-316L	
26	SMAW	SS	33	E-317	
27	SMAW	SS	34	E-317Cb	
28	SMAW	SS	35	E-318	
29	SMAW	SS	32	E-316	
30	SMAW	SS	36	E-347	
31	SMAW	SS	37	E-347	
32	SMAW	SS	38	E-347	
33	SMAW	SS	15	E-410	
34	SMAW	SS	15	E-308	
35	SMAW	SS	15	E-309	
36	SMAW	SS	15	E-316	
37	SMAW	SS	16	E-316	
38	SMAW	SS	16	E-309	
39	SMAW	SS	16	E-308	
40	SMAW	SS	16	E-410	
41	SMAW	SS	17	E-410	
42	SMAW	SS	17	E-308	
43	SMAW	SS	17	E-309	
44	SMAW	SS	17	E-312	
45	SMAW	SS	18	E-420	
46	SMAW	SS	19	E-410	

47	SMAW	SS	15	E-308	
48	SMAW	SS	15	E-308	
49	SMAW	SS	15	E-310	
50	SMAW	GCI	6	ENi-CI	(COSTLIEST
51	SMAW	GCI	6	ENiFe-CI	(LESS COSTLY)
52	SMAW	GCI	6	ESt	(LEAST COSTLY)
53	SMAW	MCI	7	ENi-CI	(COSTLIEST)
54	SMAW	MCI	7	ENiFe-CI	(LESS COSTLY)
55	SMAW	MCI	7	ESt	(LEAST COSTLY)
56	SMAW	Al	39	EA1-2 OR EA1-43	
57	SMAW	Alal	40	EA1-2 OR EA1-43	
58	SMAW	Alal	41	EA1-2 OR EA1-43	
59	SMAW	Alal	42	EA1-2 OR EA1-43	
60	SMAW	Alal	43	EA1-2 OR EA1-43	
61	SMAW	Alal	44	EA1-2 OR EA1-43	
62	SMAW	Alal	45	EA1-2 OR EA1-43	
63	SMAW	Alal	46	EA1-2 OR EA1-43	
64	SMAW	Alal	47	EA1-2 OR EA1-43	
65	SMAW	Alal	48	EA1-2 OR EA1-43	
66	SMAW	Alal	49	EA1-2 OR EA1-43	
67	SMAW	Alal	50	EA1-2 OR EA1-43	
68	SMAW	Alal	51	EA1-2 OR EA1-43	
69	SMAW	Alal	52	EA1-2 OR EA1-43	
70	SMAW	Alal	53	EA1-2 OR EA1-43	
71	SMAW	Alal	54	EA1-2 OR EA1-43	
72	SMAW	Alal	55	EA1-2 OR EA1-43	
73	SMAW	Alal	56	EA1-2 OR EA1-43	
74	SMAW	Alal	57	EA1-2 OR EA1-43	
75	SMAW	Alal	58	EA1-2 OR EA1-43	
76	SMAW	Alal	59	EA1-2 OR EA1-43	
77	SMAW	Alal	60	EA1-2 OR EA1-43	
78	SMAW	Alal	61	EA1-2 OR EA1-43	
79	SMAW	Alal	62	EA1-2 OR EA1-43	
80	SMAW	Alal	63	EA1-2 OR EA1-43	
81	SMAW	Alal	64	EA1-2 OR EA1-43	
82	SMAW	Alal	65	EA1-2 OR EA1-43	
83	SMAW	Alal	66	EA1-2 OR EA1-43	
84	SMAW	Alal	67	EA1-2 OR EA1-43	
85	SMAW	Alal	68	EA1-2 OR EA1-43	
86	SMAW	Alal	69	EA1-2 OR EA1-43	
87	SMAW	Alal	70	EA1-2 OR EA1-43	
88	SMAW	Alal	71	EA1-2 OR EA1-43	
89	SMAW	Alal	72	EA1-2 OR EA1-43	
90	SMAW	Alal	73	EA1-2 OR EA1-43	
91	SMAW	Alal	74	EA1-2 OR EA1-43	
92	SMAW	Alal	75	EA1-2 OR EA1-43	
93	SMAW	Alal	76	EA1-2 OR EA1-43	
94	SMAW	Alal	77	EA1-2 OR EA1-43	
95	SMAW	Alal	78	EA1-2 OR EA1-43	
96	SMAW	Alal	79	EA1-2 OR EA1-43	
97	SMAW	Alal	80	EA1-2 OR EA1-43	
98	SMAW	Cu	81	ECu	
99	SMAW	Cu+Zn	82	ECuSi , ECuAl-A2	
100	SMAW	Cu+Zn	82	ECuSn-A , ECuSn-C	
101	SMAW	Cu+Sn	83	ECuSn-A , ECuSn-C	
102	SMAW	Cu+Sn	83	ECuSi , ECuAl-A2	
103	SMAW	Cu+Al	84	ECuAl-A2 , ECuAl-B	
104	SMAW	Cu+Si	85	ECuAl-A2 , ECuSi	
105	SMAW	Cu+Ni	87	ECuNi	
106	SMAW	Cu+Zn+Ni	86	NO FILLER MATERIAL	
107	SMAW	Ni	92	ENi-1	
108	SMAW	Ni+Cu	93	ENiCu-7	
109	SMAW	Ni+Cr+Fe	94	ENiCrFe-1	
110	SMAW	Ni+Cr+Fe	94	ENiCrFe-2	
111	SMAW	Ni+Cr+Fe	94	ENiCrFe-3	
112	MIG	LCS	1	P2	
113	MIG	MCS	2	P2	

114	MIG	HCS	3	FZ
115	MIG	TS	4	FZ
116	MIG	CS	5	FZ
117	MIG	AS	8	FZ
118	MIG	AS	9	FZ
119	MIG	AS	10	FZ
120	MIG	AS	11	FZ
121	MIG	AS	12	FZ
122	MIG	AS	13	FZ
123	MIG	AS	14	FZ
124	MIG	GCI	6	FZ
125	MIG	MCI	7	FZ
126	MIG	SS	20	E-308
127	MIG	SS	21	E-308
128	MIG	SS	24	E-308
129	MIG	SS	26	E-308
130	MIG	SS	27	E-308
131	MIG	SS	22	E-309
132	MIG	SS	25	E-347 OR E-308L
133	MIG	SS	23	E-312
134	MIG	SS	28	E-309
135	MIG	SS	29	E-310
136	MIG	SS	30	E-316
137	MIG	SS	31	E-316L
138	MIG	SS	33	E-317
139	MIG	SS	34	E-317CB
140	MIG	SS	35	E-318
141	MIG	SS	32	E-318
142	MIG	SS	36	E-347
143	MIG	SS	37	E-347
144	MIG	SS	38	E-347
145	MIG	SS	15	E-410 OR E-308
146	MIG	SS	15	E-309 OR E-316
147	MIG	SS	16	E-309 OR E-316
148	MIG	SS	16	E-410 OR E-308
149	MIG	SS	17	E-410 OR E-308
150	MIG	SS	17	E-309 OR E-312
151	MIG	SS	18	E-420
152	MIG	SS	19	E-410 , E-309
153	MIG	SS	19	E-310 , E-308
154	MIG	Al	39	ER-1100 , ER-A1_2
155	MIG	Alal	54	ER-1100 , ER-A1_2
156	MIG	Alal	56	ER-1100 , ER-A1_2
157	MIG	Alal	55	ER-1100 , ER-A1_2
158	MIG	Alal	60	ER-1100 , ER-A1_2
159	MIG	Alal	57	ER-4145
160	MIG	Alal	58	ER-4145
161	MIG	Alal	40	ER-4145
162	MIG	Alal	41	ER-4145
163	MIG	Alal	42	ER-4145
164	MIG	Alal	43	ER-4145
165	MIG	Alal	59	ER-2319
166	MIG	Alal	61	ER-4043 , ER-A1_43
167	MIG	Alal	62	ER-4043 , ER-A1_43
168	MIG	Alal	63	ER-4043 , ER-A1_43
169	MIG	Alal	72	ER-4043 , ER-A1_43
170	MIG	Alal	73	ER-4043 , ER-A1_43
171	MIG	Alal	74	ER-4043 , ER-A1_43
172	MIG	Alal	75	ER-4043 , ER-A1_43
173	MIG	Alal	76	ER-4043 , ER-A1_43
174	MIG	Alal	77	ER-4043 , ER-A1_43
175	MIG	Alal	78	ER-4043 , ER-A1_43
176	MIG	Alal	44	ER-4043 , ER-A1_43
177	MIG	Alal	45	ER-4043 , ER-A1_43
178	MIG	Alal	46	ER-4043 , ER-A1_43
179	MIG	Alal	47	ER-5654
180	MIG	Alal	48	ER-5654
181	MIG	Alal	49	ER-5654
182	MIG	Alal	50	ER-5654
183	MIG	Alal	64	ER-5654
184	MIG	Alal	67	ER-5654

MIG	Alal	68 ER-5654	
MIG	Alal	71 ER-5654	
MIG	Alal	65 ER-5183	
MIG	Alal	66 ER-5356	
MIG	Alal	79 ER-5356	
MIG	Alal	80 ER-5356	
MIG	Alal	51 ER-5356	
MIG	Alal	52 ER-5356	
MIG	Alal	53 ER-5356	
MIG	Alal	69 ER-5554	
MIG	Alal	70 ER-5556	
MIG	Cu	81 ERCu	
MIG	Cu+Zn	82 ERCuSi-A , ERCuSn-A	
MIG	Cu+Sn	83 ERCuSn-A	
MIG	Cu+Al	84 ERCuAl-A2	
MIG	Cu+Si	85 ERCuSi-A	
MIG	Cu+Ni	87 ERCuNi-A	
MIG	Cu+Zn+Ni	86 NO FILLER MATERIAL	
MIG	Ni	92 ERNi-1	
MIG	Ni+Cu	93 ERNiCu-7 , ERCuNi	
MIG	Ni+Cr+Fe	94 ERNiCrFe-1	
MIG	Ni+Cr+Fe	94 ERNiCrFe-5	
MIG	Ni+Cr+Fe	94 ERNiCrFe-6	
MIG	Mg	90 ERAZ61-A , ERAZ101-A	
MIG	Mg	90 ERAZ92-A , ERAZ33-A	
MIG	Ti	101 ERTi	
MIG	Tial	102 ERTi	
MIG	Ta	99 ROD OF SAME JOB (WP)	
MIG	Be	111 ROD OF SAME JOB (WP)	
MIG	Mo	91 TZM MOLYBDENUM	
MIG	Mo	91 Mo-RHENIUM ALLOY	
MIG	W	112 W-RHENIUM ALLOY	
MIG	Zr	103 ERZr-2,ERZr-3,ERZr-4	
MIG	Hf	104 ERHf	
MIG	Ag	97 ROD OF SAME JOB (WP)	
MIG	Pt	98 ROD OF SAME JOB (WP)	
TIG	LCS	1 P2	EWTh OR EWZr
TIG	MCS	2 P2	EWTh OR EWZr
TIG	HCS	3 P2	EWTh OR EWZr
TIG	TS	4 P2	EWTh OR EWZr
TIG	CS	5 P2	EWTh
TIG	GCI	6 P2	EWTh
TIG	MCI	7 P2	EWTh OR EWZr
TIG	AS	8 P2	EWTh OR EWZr
TIG	AS	9 P2	EWTh OR EWZr
TIG	AS	10 P2	EWTh OR EWZr
TIG	AS	11 P2	EWTh OR EWZr
TIG	AS	12 P2	EWTh OR EWZr
TIG	AS	13 P2	EWTh OR EWZr
TIG	AS	14 P2	EWTh
TIG	SS	20 ER-308	EWTh
TIG	SS	21 ER-308	EWTh
TIG	SS	24 ER-308	EWTh
TIG	SS	26 ER-308	EWTh
TIG	SS	27 ER-308	EWTh
TIG	SS	22 ER-309	EWTh
TIG	SS	25 ER-347 , ER-308L	EWTh
TIG	SS	23 ER-312	EWTh
TIG	SS	28 ER-309	EWTh
TIG	SS	29 ER-310	EWTh
TIG	SS	30 ER-316	EWTh
TIG	SS	31 ER-316L	EWTh
TIG	SS	33 ER-317	EWTh
TIG	SS	34 ER-317Cb	EWTh
TIG	SS	35 ER-318	EWTh
TIG	SS	32 ER-318	EWTh
TIG	SS	36 ER-347	EWTh
TIG	SS	37 ER-347	

TIG	SS	38 ER-347		EWTh
TIG	SS	15 ER-410 , ER-308		EWTh
TIG	SS	15 ER-316 , ER-309		EWTh
TIG	SS	16 ER-316 , ER-309		EWTh
TIG	SS	16 ER-410 , ER-308		EWTh
TIG	SS	17 ER-410 , ER-308		EWTh
TIG	SS	17 ER-312 , ER-309		EWTh
TIG	SS	18 ER-420		EWTh
TIG	SS	19 ER-410 , ER-308		EWTh
TIG	SS	19 ER-310 , ER-309		EWTh
TIG	Al	39 ER-1100 , ER-A1_2		EWP OR EWZr
TIG	Alal	54 ER-1100 , ER-A1_2		EWP OR EWZr
TIG	Alal	56 ER-1100 , ER-A1_2		EWP OR EWZr
TIG	Alal	55 ER-1100 , ER-A1_2		EWP OR EWZr
TIG	Alal	60 ER-1100 , ER-A1_2		EWP OR EWZr
TIG	Alal	57 ER-4145		EWP OR EWZr
TIG	Alal	58 ER-4145		EWP OR EWZr
TIG	Alal	40 ER-4145		EWP OR EWZr
TIG	Alal	41 ER-4145		EWP OR EWZr
TIG	Alal	42 ER-4145		EWP OR EWZr
TIG	Alal	43 ER-4145		EWP OR EWZr
TIG	Alal	59 ER-2319		EWP OR EWZr
TIG	Alal	61 ER-4043 , ER-A1_43		EWP OR EWZr
TIG	Alal	62 ER-4043 , ER-A1_43		EWP OR EWZr
TIG	Alal	63 ER-4043 , ER-A1_43		EWP OR EWZr
TIG	Alal	72 ER-4043 , ER-A1_43		EWP OR EWZr
TIG	Alal	73 ER-4043 , ER-A1_43		EWP OR EWZr
TIG	Alal	74 ER-4043 , ER-A1_43		EWP OR EWZr
TIG	Alal	75 ER-4043 , ER-A1_43		EWP OR EWZr
TIG	Alal	76 ER-4043 , ER-A1_43		EWP OR EWZr
TIG	Alal	77 ER-4043 , ER-A1_43		EWP OR EWZr
TIG	Alal	78 ER-4043 , ER-A1_43		EWP OR EWZr
TIG	Alal	44 ER-4043 , ER-A1_43		EWP OR EWZr
TIG	Alal	45 ER-4043 , ER-A1_43		EWP OR EWZr
TIG	Alal	46 ER-4043 , ER-A1_43		EWP OR EWZr
TIG	Alal	64 ER-5654		EWP OR EWZr
TIG	Alal	71 ER-5654		EWP OR EWZr
TIG	Alal	67 ER-5654		EWP OR EWZr
TIG	Alal	68 ER-5654		EWP OR EWZr
TIG	Alal	47 ER-5654		EWP OR EWZr
TIG	Alal	48 ER-5654		EWP OR EWZr
TIG	Alal	49 ER-5654		EWP OR EWZr
TIG	Alal	50 ER-5654		EWP OR EWZr
TIG	Alal	65 ER-5183		EWP OR EWZr
TIG	Alal	66 ER-5356		EWP OR EWZr
TIG	Alal	79 ER-5356		EWP OR EWZr
TIG	Alal	80 ER-5356		EWP OR EWZr
TIG	Alal	51 ER-5356		EWP OR EWZr
TIG	Alal	52 ER-5356		EWP OR EWZr
TIG	Alal	53 ER-5356		EWP OR EWZr
TIG	Alal	69 ER-5554		EWP OR EWZr
TIG	Alal	70 ER-5556		EWP OR EWZr
TIG	Cu	81 ERCu		EWTh-2
TIG	Cu	106 ROD OF SAME JOB(WP)		EWTh1 OR EWTh2
TIG	Cu+Zn	82 ERCuSn-A	LOW Zn	EWTh-2
TIG	Cu+Zn	82 ERCuSi-A , ERCuAl-2	HIGH Zn	EWTh-2
TIG	Cu+Sn	83 ERCuSi-A	STRONG WELD	EWTh-2
TIG	Cu+Sn	83 ERCuSn-A	ORDINARILY	EWTh-2
TIG	Cu+Al	84 ERCuAl-A2	ORDINARILY	EWZr OR EWP
TIG	Cu+Al	84 ERCuAl-A3		EWZr OR EWP
TIG	Cu+Si	85 ERCuSi-A		EWZr OR EWP
TIG	Cu+Ni	87 ERCuNi		EWZr OR EWP
TIG	Cu+Zn+Ni	86 NO FILLER MATERIAL		EWTh-2
TIG	Ni	92 ERNi-1		EWTh-2 OR EWZr
TIG	Ni+Cu	93 ERNiCu-7 , ERCuNi		EWTh-2 OR EWZr
TIG	Ni+Cr+Fe	94 ERNiCrFe-5 (PREFERRED)	PREFERRED	EWTh-2 OR EWZr
TIG	Ni+Cr+Fe	94 ERNiCrFe-6		EWTh-2 OR EWZr

TIG	Mg	93 ERAZ61A , ERAZ101A		EWP OR EWTh-2
TIG	Mg	93 ERAZ92A , ERAZ33A		EWP OR EWTh-2
TIG	Ti	101 ERTi		EWTh-1 (OR 2)
TIG	Ti al	102 ERTi		EWTh-1 (OR 2)
TIG	Zr	103 ERZr-2,ERZr-3,ERZr-4		EWTh-1 (OR 2)
TIG	Hf	104 ERHf		EWTh-1 (OR 2)
TIG	Nb OR Cb	100 NO FILLER MATERIAL		EWTh-1 (OR 2)
TIG	Ta	99 ROD OF SAME JOB (WP)		EWTh-1 (OR 2)
TIG	Be	111 ROD OF SAME JOB (WP)		EWTh-1 (OR 2)
TIG	Mo	91 TZM MOLYBDENUM		EWTh-1 (OR 2)
TIG	Mo	91 Mo-RHENIUM ALLOY		EWTh-1 (OR 2)
TIG	W	112 W-RHENIUM ALLOY		EWTh-1 (OR 2)
TIG	Cr	116 NO FILLER MATERIAL		EWTh
TIG	Ag	97 ROD OF SAME JOB (WP)		EWTh
TIG	Pt	98 ROD OF SAME JOB (WP)		EWTh
SAW	LCS	1 P3		
SAW	MCS	2 P3		
SAW	HCS	3 P3		
SAW	TS	4 P3		
SAW	CS	5 EH14		
SAW	GCI	6 EL8,EL8K,EL12 (LOW Mn)	LOW Mn	
SAW	MCI	7 EL8,EL8K,EL12 (LOW Mn)	LOW Mn	
SAW	AS	8 P3		
SAW	AS	9 P3		
SAW	AS	10 P3		
SAW	AS	11 P3		
SAW	AS	12 P3		
SAW	AS	13 P3		
SAW	AS	14 P3		
SAW	SS	20 ER-308		
SAW	SS	21 ER-308		
SAW	SS	24 ER-308		
SAW	SS	26 ER-308		
SAW	SS	27 ER-308		
SAW	SS	22 ER-309		
SAW	SS	25 ER-347 , ER-308L		
SAW	SS	23 ER-312		
SAW	SS	28 ER-309		
SAW	SS	29 ER-310		
SAW	SS	30 ER-316		
SAW	SS	31 ER-316L		
SAW	SS	33 ER-317		
SAW	SS	34 ER-317Cb		
SAW	SS	35 ER-318		
SAW	SS	32 ER-318		
SAW	SS	36 ER-347		
SAW	SS	37 ER-347		
SAW	SS	38 ER-347		
SAW	SS	15 ER-410 , ER-308		
SAW	SS	15 ER-316 , ER-309		
SAW	SS	16 ER-316 , ER-309		
SAW	SS	16 ER-410 , ER-308		
SAW	SS	17 ER-410 , ER-308		
SAW	SS	17 ER-312 , ER-309		
SAW	SS	18 ER-420		
SAW	SS	19 ER-410 , ER-308		
SAW	SS	19 ER-310 , ER-309		
SAW	Ni	92 ERNi-1		
SAW	Ni+Cu	93 ERCuNi , ERNiCu-7		
SAW	Ni+Cr+Fe	94 ERNiCrFe-5		
SAW	Cu	81 UNDER DEVELOPMENT		
SAW	Cu+Zn	82 UNDER DEVELOPMENT		
SAW	Cu+Sn	83 UNDER DEVELOPMENT		
SAW	Cu+Al	84 UNDER DEVELOPMENT		
SAW	Cu+Si	85 UNDER DEVELOPMENT		
SAW	Cu+Ni	87 UNDER DEVELOPMENT		
SAW	Cu+Zn+Ni	86 UNDER DEVELOPMENT		
PAW	LCS	1 P2		EWTh OR EWZr

PAW	MIG	2 P2	EWTh OR EWZr
PAW	HIG	3 P2	EWTh OR EWZr
PAW	TIG	4 P2	EWTh OR EWZr
PAW	GTAW	6 P2	EWTh
PAW	MCAW	7 P2	EWTh
PAW	AS	8 P2	EWTh OR EWZr
PAW	AS	9 P2	EWTh OR EWZr
PAW	AS	10 P2	EWTh OR EWZr
PAW	AS	11 P2	EWTh OR EWZr
PAW	AS	12 P2	EWTh OR EWZr
PAW	AS	13 P2	EWTh OR EWZr
PAW	AS	14 P2	EWTh OR EWZr
PAW	SS	20 ER-308	EWTh
PAW	SS	21 ER-308	EWTh
PAW	SS	24 ER-308	EWTh
PAW	SS	26 ER-308	EWTh
PAW	SS	27 ER-308	EWTh
PAW	SS	22 ER-309	EWTh
PAW	SS	25 ER-347 , ER-308L	EWTh
PAW	SS	23 ER-312	EWTh
PAW	SS	28 ER-309	EWTh
PAW	SS	29 ER-310	EWTh
PAW	SS	30 ER-316	EWTh
PAW	SS	31 ER-316L	EWTh
PAW	SS	33 ER-317	EWTh
PAW	SS	34 ER-317Cb	EWTh
PAW	SS	35 ER-318	EWTh
PAW	SS	32 ER-318	EWTh
PAW	SS	36 ER-347	EWTh
PAW	SS	37 ER-347	EWTh
PAW	SS	38 ER-347	EWTh
PAW	SS	15 ER-410 , ER-308	EWTh
PAW	SS	15 ER-316 , ER-309	EWTh
PAW	SS	16 ER-316 , ER-309	EWTh
PAW	SS	16 ER-410 , ER-308	EWTh
PAW	SS	17 ER-410 , ER-308	EWTh
PAW	SS	17 ER-312 , ER-309	EWTh
PAW	SS	18 ER-420	EWTh
PAW	SS	19 ER-410 , ER-308	EWTh
PAW	SS	19 ER-310 , ER-309	EWTh
PAW	Al	39 ER-1100 , ER-A1_2	EWP OR EWZr
PAW	Alal	54 ER-1100 , ER-A1_2	EWP OR EWZr
PAW	Alal	55 ER-1100 , ER-A1_2	EWP OR EWZr
PAW	Alal	56 ER-1100 , ER-A1_2	EWP OR EWZr
PAW	Alal	60 ER-1100 , ER-A1_2	EWP OR EWZr
PAW	Alal	57 ER-4145	EWP OR EWZr
PAW	Alal	58 ER-4145	EWP OR EWZr
PAW	Alal	40 ER-4145	EWP OR EWZr
PAW	Alal	41 ER-4145	EWP OR EWZr
PAW	Alal	42 ER-4145	EWP OR EWZr
PAW	Alal	43 ER-4145	EWP OR EWZr
PAW	Alal	59 ER-2319	EWP OR EWZr
PAW	Alal	61 ER-4043 , ER-A1_43	EWP OR EWZr
PAW	Alal	62 ER-4043 , ER-A1_43	EWP OR EWZr
PAW	Alal	63 ER-4043 , ER-A1_43	EWP OR EWZr
PAW	Alal	72 ER-4043 , ER-A1_43	EWP OR EWZr
PAW	Alal	73 ER-4043 , ER-A1_43	EWP OR EWZr
PAW	Alal	74 ER-4043 , ER-A1_43	EWP OR EWZr
PAW	Alal	75 ER-4043 , ER-A1_43	EWP OR EWZr
PAW	Alal	76 ER-4043 , ER-A1_43	EWP OR EWZr
PAW	Alal	77 ER-4043 , ER-A1_43	EWP OR EWZr
PAW	Alal	78 ER-4043 , ER-A1_43	EWP OR EWZr
PAW	Alal	44 ER-4043 , ER-A1_43	EWP OR EWZr
PAW	Alal	45 ER-4043 , ER-A1_43	EWP OR EWZr
PAW	Alal	46 ER-4043 , ER-A1_43	EWP OR EWZr
PAW	Alal	64 ER-5654	EWP OR EWZr
PAW	Alal	71 ER-5654	EWP OR EWZr

AW	Alal	57	ER-5654			EWP OR EWZr
AW	Alal	58	ER-5654			EWP OR EWZr
AW	Alal	47	ER-5654			EWP OR EWZr
AW	Alal	48	ER-5654			EWP OR EWZr
AW	Alal	49	ER-5654			EWP OR EWZr
AW	Alal	50	ER-5654			EWP OR EWZr
AW	Alal	65	ER-5183			EWP OR EWZr
AW	Alal	66	ER-5356			EWP OR EWZr
AW	Alal	79	ER-5356			EWP OR EWZr
AW	Alal	80	ER-5356			EWP OR EWZr
AW	Alal	51	ER-5356			EWP OR EWZr
AW	Alal	52	ER-5356			EWP OR EWZr
AW	Alal	53	ER-5356			EWP OR EWZr
AW	Alal	69	ER-5554			EWP OR EWZr
AW	Alal	70	ER-5556			EWP OR EWZr
AW	Cu	81	ERCu			EWTh-2
AW	Cu+Zn	82	ERCuSn-A	(LOW Zn)	LOW Zn	EWTh-2
AW	Cu+Zn	82	ERCuSi-A , ERCuAl-2	(HIGH Zn)	HIGH Zn	EWTh-2
AW	Cu+Sn	83	ERCuSn-A	(ORDINARILY)	ORDINARILY	EWTh-2
AW	Cu+Sn	83	ERCuSi-A	(STRONG WELD)	STRONG WELD	EWTh-2
AW	Cu+Al	84	ERCuAl-A2	(ORDINARILY)	ORDINARILY	EWZr OR EWP
AW	Cu+Al	84	ERCuAl-A3			EWZr OR EWP
AW	Cu+Si	85	ERCuSi-A			EWZr OR EWP
AW	Cu+Ni	87	ERCuNi			EWZr OR EWP
AW	Cu+Zn+Ni	86	NO FILLER MATERIAL			EWTh-2
AW	Ni	92	ERNi-1			EWTh-2 OR EWZr
AW	Ni+Cu	93	ERNiCu-7 , ERCuNi			EWTh-2 OR EWZr
AW	Ni+Cr+Fe	94	ERNiCrFe-5			EWTh-2 OR EWZr
AW	Ni+Cr+Fe	94	ERNiCrFe-6			EWTh-2 OR EWZr
AW	Ni+Cr+Fe	94	ERNiCrFe-1			EWTh-2 OR EWZr
AW	Mg	90	ERAZ61A , ERAZ101A			EWP OR EWTh-2
AW	Mg	90	ERAZ92A , ERAZ33A			EWP OR EWTh-2
AW	Ti	101	ERTi			EWTh-1 (OR 2)
AW	Tial	102	ERTi			EWTh-1 (OR 2)
AW	Zr	103	ERZr2, ERZR3, ERZr4			EWTh-1 (OR 2)
AW	Hf	104	ERHf			EWTh-1 (OR 2)
AW	Ta	99	ROD OF SAME JOB (WP)			EWTh-1 (OR 2)
AW	Be	111	ROD OF SAME JOB (WP)			EWTh-1 (OR 2)
AW	Co	106	ROD OF SAME JOB (WP)			EWTh-1 (OR 2)
AW	Cr	116	NO FILLER MATERIAL			EWTh
AW	LCS	1	P2			C OR GRAPHITE
AW	MCS	2	P2			C OR GRAPHITE
AW	GCI	6	P2			C OR GRAPHITE
AW	MCI	7	P2			C OR GRAPHITE
AW	Al	39	ER-1100 , ER-A1_2			C WITH 5% Si
AW	Alal	54	ER-1100 , ER-A1_2			C WITH 5% Si
AW	Alal	56	ER-1100 , ER-A1_2			C WITH 5% Si
AW	Alal	55	ER-1100 , ER-A1_2			C WITH 5% Si
AW	Alal	60	ER-1100 , ER-A1_2			C WITH 5% Si
AW	Alal	57	ER-4145			C WITH 5% Si
AW	Alal	58	ER-4145			C WITH 5% Si
AW	Alal	40	ER-4145			C WITH 5% Si
AW	Alal	41	ER-4145			C WITH 5% Si
AW	Alal	42	ER-4145			C WITH 5% Si
AW	Alal	43	ER-4145			C WITH 5% Si
AW	Alal	59	ER-2319			C WITH 5% Si
AW	Alal	61	ER-4043 , ER-A1_43			C WITH 5% Si
AW	Alal	62	ER-4043 , ER-A1_43			C WITH 5% Si
AW	Alal	63	ER-4043 , ER-A1_43			C WITH 5% Si
AW	Alal	72	ER-4043 , ER-A1_43			C WITH 5% Si
AW	Alal	73	ER-4043 , ER-A1_43			C WITH 5% Si
AW	Alal	74	ER-4043 , ER-A1_43			C WITH 5% Si
AW	Alal	75	ER-4043 , ER-A1_43			C WITH 5% Si
AW	Alal	76	ER-4043 , ER-A1_43			C WITH 5% Si
AW	Alal	77	ER-4043 , ER-A1_43			C WITH 5% Si
AW	Alal	78	ER-4043 , ER-A1_43			C WITH 5% Si
AW	Alal	44	ER-4043 , ER-A1_43			C WITH 5% Si
AW	Alal	45	ER-4043 , ER-A1_43			C WITH 5% Si

CAW	Alal	46	ER-4043 , ER-A1_43	C WITH 5% Si
CAW	Alal	64	ER-5654	C WITH 5% Si
CAW	Alal	67	ER-5654	C WITH 5% Si
CAW	Alal	68	ER-5654	C WITH 5% Si
CAW	Alal	71	ER-5654	C WITH 5% Si
CAW	Alal	47	ER-5654	C WITH 5% Si
CAW	Alal	48	ER-5654	C WITH 5% Si
CAW	Alal	49	ER-5654	C WITH 5% Si
CAW	Alal	50	ER-5654	C WITH 5% Si
CAW	Alal	65	ER-5183	C WITH 5% Si
CAW	Alal	66	ER-5356	C WITH 5% Si
CAW	Alal	79	ER-5356	C WITH 5% Si
CAW	Alal	80	ER-5356	C WITH 5% Si
CAW	Alal	51	ER-5356	C WITH 5% Si
CAW	Alal	52	ER-5356	C WITH 5% Si
CAW	Alal	53	ER-5356	C WITH 5% Si
CAW	Alal	69	ER-5554	C WITH 5% Si
CAW	Alal	70	ER-5556	C WITH 5% Si
CAW	Cu	81	ERCu	C OR GRAPHITE
CAW	Cu+Zn	82	ERCuSi-A , ERCuSn-A	C OR GRAPHITE
CAW	Cu+Sn	83	ERCuSn-A	C OR GRAPHITE
CAW	Cu+Al	84	ERCuAl-A2	C OR GRAPHITE
CAW	Cu+Si	85	ERCuSi-A	C OR GRAPHITE
CAW	Cu+Ni	87	ERCuNi-A	C OR GRAPHITE
CAW	Cu+Zn+Ni	86	NO FILLER MATERIAL	C OR GRAPHITE
CAW	Ni	92	ERNi-1	C OR GRAPHITE
CAW	Ni+Cu	93	ERNiCu-7 , ERCuNi	C OR GRAPHITE
CAW	Ni+Cr+Fe	94	ERNiCrFe-5	C OR GRAPHITE
CAW	Ni+Cr+Fe	94	ERNiCrFe-6	C OR GRAPHITE
CAW	Ni+Cr+Fe	94	ERNiCrFe-1	C OR GRAPHITE
CAW	Mo	91	TZM MOLYBDENUM	C OR GRAPHITE
CAW	Mo	91	Mo-RHENIUM ALLOY	C OR GRAPHITE
CAW	Pt	98	ROD OF SAME JOB (WP)	C OR GRAPHITE
CAW	Ta	99	ROD OF SAME JOB (WP)	C OR GRAPHITE
ESW	LCS	1	EM12-EW , EM12K-EW (LOW YS,TS,HRC)	LOW YS, TS, HRC
ESW	LCS	1	EM5K-EW (LOW YS,TS,HRC)	LOW YS, TS, HRC
ESW	LCS	1	EM13K-EW,EM15K-EW (LOW YS,TS,HRC)	LOW YS, TS, HRC
ESW	LCS	1	EH10Mo-EW,EH10K-EW (HIGH YS,TS,HRC)	HIGH YS,TS,HRC
ESW	LCS	1	EH11K-EW , EH14-EW (HIGH YS,TS,HRC)	HIGH YS,TS,HRC
ESW	MCS	2	EWT1,EWT2,EWT3,EWT4	
ESW	HCS	3	EWT1,EWT2,EWT3,EWT4	
ESW	TS	3	EWT1,EWT2,EWT3,EWT4	
ESW	GCI	6	EL8 , EL8K , EL12	
ESW	MCI	7	EL8 , EL8K , EL12	
ESW	SS	15	ER209,ER218,ER240	
ESW	SS	16	ER209,ER218,ER240	
ESW	SS	17	ER209,ER218,ER240	
ESW	SS	18	ER209,ER218,ER240	
ESW	SS	19	ER209,ER218,ER240	
ESW	SS	20	ER209,ER218,ER240	
ESW	SS	21	ER209,ER218,ER240	
ESW	SS	22	ER209,ER218,ER240	
ESW	SS	23	ER209,ER218,ER240	
ESW	SS	24	ER209,ER218,ER240	
ESW	SS	25	ER209,ER218,ER240	
ESW	SS	26	ER209,ER218,ER240	
ESW	SS	27	ER209,ER218,ER240	
ESW	SS	28	ER209,ER218,ER240	
ESW	SS	29	ER209,ER218,ER240	
ESW	SS	30	ER209,ER218,ER240	
ESW	SS	31	ER209,ER218,ER240	
ESW	SS	32	ER209,ER218,ER240	
ESW	SS	33	ER209,ER218,ER240	
ESW	SS	34	ER209,ER218,ER240	
ESW	SS	35	ER209,ER218,ER240	
ESW	SS	36	ER209,ER218,ER240	
ESW	SS	37	ER209,ER218,ER240	

590	ESW	SS	38	ER209,ER218,ER240		
591	ESW	Ni	92	ERNi-1		
592	ESW	Ni+Cu	93	ERCuNi , ERNiCu-7		
593	ESW	Ni+Cr+Fe	94	ERNiCrFe-5		
594	ESW	Ti	101	ERTi-EW		
595	ESW	Tial	102	ERTi-EW		
596	EGW	LCS	1	P4		
597	EGW	MCS	2	P4		
598	EGW	CS	5	P4		
599	EGW	AS	8	P4		
600	EGW	AS	9	P4		
601	EGW	AS	10	P4		
602	EGW	AS	11	P4		
603	EGW	AS	12	P4		
604	EGW	AS	13	P4		
605	EGW	AS	14	P4		
606	EGW	SS	20	EG308S	(SOLID WIRE)	SOLID WIRE
607	EGW	SS	20	EG308T	(FLUX CORED WIRE)	FLUX CORED WIRE
608	EGW	SS	21	EG308T	(FLUX CORED WIRE)	FLUX CORED WIRE
609	EGW	SS	21	EG308S	(SOLID WIRE)	SOLID WIRE
610	EGW	SS	24	EG308S	(SOLID WIRE)	SOLID WIRE
611	EGW	SS	24	EG308T	(FLUX CORED WIRE)	FLUX CORED WIRE
612	EGW	SS	26	EG308T	(FLUX CORED WIRE)	FLUX CORED WIRE
613	EGW	SS	26	EG308S	(SOLID WIRE)	SOLID WIRE
614	EGW	SS	27	EG308S	(SOLID WIRE)	SOLID WIRE
615	EGW	SS	27	EG308T	(FLUX CORED WIRE)	FLUX CORED WIRE
616	EGW	SS	22	EG309S,EG309T	(SOLID,FLUX CORED)	SOLID , FC WIRE
617	EGW	SS	25	EG347S,EG347T	(SOLID ,FLUX CORED)	SOLID , FC WIRE
618	EGW	SS	25	EG308LS,EG308LT	(SOLID, FLUX CORED)	SOLID , FC WIRE
619	EGW	SS	23	EG312S,EG312T	(SOLID,FLUX CORED)	SOLID , FC WIRE
620	EGW	SS	28	EG309S,EG309T	(SOLID,FLUX CORED)	SOLID , FC WIRE
621	EGW	SS	29	EG310S,EG310T	(SOLID,FLUX CORED)	SOLID , FC WIRE
622	EGW	SS	30	EG316S,EG316T	(SOLID,FLUX CORED)	SOLID , FC WIRE
623	EGW	SS	31	EG316LS,EG316LT	(SOLID,FLUX CORED)	SOLID , FC WIRE
624	EGW	SS	33	EG317S,EG317T	(SOLID,FLUX CORED)	SOLID , FC WIRE
625	EGW	SS	34	EG317CbS,EG317CbT	(SOLID,FLUX CORED)	SOLID , FC WIRE
626	EGW	SS	35	EG318S , EG318T	(SOLID,FLUX CORED)	SOLID , FC WIRE
627	EGW	SS	32	EG318S , EG318T	(SOLID,FLUX CORED)	SOLID , FC WIRE
628	EGW	SS	36	EG347S , EG347T	(SOLID,FLUX CORED)	SOLID , FC WIRE
629	EGW	SS	37	EG347S , EG347T	(SOLID,FLUX CORED)	SOLID , FC WIRE
630	EGW	SS	38	EG347S , EG347T	(SOLID,FLUX CORED)	SOLID , FC WIRE
631	EGW	Ni	92	EGNiS-1,EGNiT-1	(SOLID,FLUX CORED)	SOLID , FC WIRE
632	EGW	Ni+Cu	93	EGNiCuS-7,EGNiCuT-7	(SOLID,FC WIRE)	SOLID , FC WIRE
633	EGW	Ni+Cr+Fe	94	EGNiCrFeS-1	(SOLID)	SOLID
634	EGW	Ni+Cr+Fe	94	EGNiCrFeS-2	(SOLID)	SOLID
635	EGW	Ni+Cr+Fe	94	EGNiCrFeS-3	(FLUX CORED WIRE)	SOLID
636	EGW	Ni+Cr+Fe	94	EGNiCrFeT-3	(FLUX CORED WIRE)	FLUX CORED WIRE
637	EGW	Ni+Cr+Fe	94	EGNiCrFeT-2	(FLUX CORED WIRE)	FLUX CORED WIRE
638	EGW	Ni+Cr+Fe	94	EGNiCrFeT-1	(FLUX CORED WIRE)	FLUX CORED WIRE

BRAZFILL.DBF (Filler materials & heating methods for brazing)

Fields name → / Records ↓	notation (Notation1)	notation (Notation2)	Filler material code (Fill_Code)	Recommended heating method (HPstAM_R)	Limited use heating method (HPstAM_L)
1	Al	Al	A	TDF	IRN
2	Al	Alal	A	TDF	IRN
3	Al	Be	A	Z	Z
4	Al	CS	A	Z	Z
5	Al	HCS	A	Z	Z
6	Al	AS	A	Z	Z
7	Al	LCS	A	Z	Z
8	Al	MCS	A	Z	Z
9	Al	SS	A	Z	Z
10	Al	Ti	A	Z	Z
11	Al	Tial	A	Z	Z
12	Alal	Alal	A	TDF	IRN
13	Alal	Be	A	Z	Z
14	Alal	CS	A	Z	Z
15	Alal	HCS	A	Z	Z
16	Alal	AS	A	Z	Z
17	Alal	LCS	A	Z	Z
18	Alal	MCS	A	Z	Z
19	Alal	SS	A	Z	Z
20	Alal	Ti	A	Z	Z
21	Alal	Tial	A	Z	Z
22	Cu+Al	Cu+Zn	FGDE	TDFIR	Z
23	Cu+Al	Cu+Al	F	TDFIR	Z
24	Cu+Al	Cu+Sn	FGDE	TDFIR	Z
25	Cu+Al	Cu+Si	FGDE	TDFIR	Z
26	Cu+Al	Cu+Zn+Ni	FGDE	TDFIR	Z
27	Cu+Al	Cu+Ni	FGDE	TDFIR	Z
28	Cu+Al	CS	FGE	Z	Z
29	Cu+Al	Cm	FGC	Z	Z
30	Cu+Al	Cu	FGDE	TDFIR	Z
31	Cu+Al	Gp	X	Z	Z
32	Cu+Al	GCI	FGE	Z	Z
33	Cu+Al	MCI	FGE	Z	Z
34	Cu+Al	HCS	FGE	Z	Z
35	Cu+Al	Ni+Cr+Fe	FGE	Z	Z
36	Cu+Al	Ni+Cu	FGE	Z	Z
37	Cu+Al	Ni	FGE	Z	Z
38	Cu+Al	Nm	FGE	Z	Z
39	Cu+Al	AS	FGE	Z	Z
40	Cu+Al	LCS	FGE	Z	Z
41	Cu+Al	MCS	FGE	Z	Z
42	Cu+Al	Mo	F	Z	Z
43	Cu+Al	Nb OR Cb	F	Z	Z
44	Cu+Al	SS	FG	Z	Z
45	Cu+Al	Ta	F	Z	Z
46	Cu+Al	Ti	F	Z	Z
47	Cu+Al	Tial	F	Z	Z
48	Cu+Al	TS	FGEH	Z	Z
49	Cu+Al	W	F	Z	Z
50	Be	Be	AF	F	Z
51	Be	CS	F	Z	Z
52	Be	Cm	F	Z	Z
53	Be	Gp	X	Z	Z
54	Be	GCI	FH	Z	Z
55	Be	HCS	F	Z	Z
56	Be	Ni+Cr+Fe	FH	Z	Z
57	Be	Cu+Zn+Ni	FH	Z	Z
58	Be	Nm	FH	Z	Z
59	Be	AS	F	Z	Z
60	Be	CS	F	Z	Z
61	Be	LCS	F	Z	Z
62	Be	MCS	F	Z	Z
63	Be	HCS	F	Z	Z
64	Be	SS	FH	Z	Z
65	Be	Ti	FH	Z	Z
66	Be	Tial	FH	Z	Z
67	Cu+Zn	Cu+Zn	FD	FTIRD	Z

68	Cu+Zn	Cu+Sn	FGDE	FTIRD	Z
69	Cu+Zn	Cu+Si	FGDE	FTIRD	Z
70	Cu+Zn	Cu+Ni	FGDE	FTIRD	Z
71	Cu+Zn	Cu+Zn+Ni	FGDE	FTIRD	Z
72	Cu+Zn	GCI	FGE	Z	Z
73	Cu+Zn	MCI	FGE	Z	Z
74	Cu+Zn	Cm	FGC	Z	Z
75	Cu+Zn	Nb OR Cb	F	Z	Z
76	Cu+Zn	Cu	FGDE	FTIRD	Z
77	Cu+Zn	Gp	X	Z	Z
78	Cu+Zn	Mo	F	Z	Z
79	Cu+Zn	Ni+Cu	FGE	Z	Z
80	Cu+Zn	Ni	FGE	Z	Z
81	Cu+Zn	Ni+Cr+Fe	FGE	Z	Z
82	Cu+Zn	Nm	FGE	Z	Z
83	Cu+Zn	AS	FGE	Z	Z
84	Cu+Zn	CS	FGE	Z	Z
85	Cu+Zn	LCS	FGE	Z	Z
86	Cu+Zn	MCS	FGE	Z	Z
87	Cu+Zn	HCS	FGE	Z	Z
88	Cu+Zn	SS	FG	Z	Z
89	Cu+Zn	TS	FGEH	Z	Z
90	Cu+Zn	Ta	F	Z	Z
91	Cu+Zn	Ti	F	Z	Z
92	Cu+Zn	Tial	F	Z	Z
93	Cu+Zn	W	F	Z	Z
94	Cu+Sn	Cu+Sn	FD	FTIRD	Z
95	Cu+Sn	Cu+Si	FGDE	FTIRD	Z
96	Cu+Sn	Cu+Ni	FGDE	FTIRD	Z
97	Cu+Sn	Cu+Zn+Ni	FGDE	FTIRD	Z
98	Cu+Sn	Cu	FGDE	FTIRD	Z
99	Cu+Sn	GCI	FGE	Z	Z
100	Cu+Sn	MCI	FGE	Z	Z
101	Cu+Sn	Cm	FGC	Z	Z
102	Cu+Sn	Nb OR Cb	F	Z	Z
103	Cu+Sn	Gp	J	Z	Z
104	Cu+Sn	Mo	F	Z	Z
105	Cu+Sn	Ni+Cu	FGE	Z	Z
106	Cu+Sn	Ni	FGE	Z	Z
107	Cu+Sn	Ni+Cr+Fe	FGE	Z	Z
108	Cu+Sn	Nm	FGE	Z	Z
109	Cu+Sn	AS	FGE	Z	Z
110	Cu+Sn	CS	FGE	Z	Z
111	Cu+Sn	LCS	FGE	Z	Z
112	Cu+Sn	MCS	FGE	Z	Z
113	Cu+Sn	HCS	FGE	Z	Z
114	Cu+Sn	SS	FG	Z	Z
115	Cu+Sn	TS	FGEH	Z	Z
116	Cu+Sn	Ta	F	Z	Z
117	Cu+Sn	Ti	F	Z	Z
118	Cu+Sn	Tial	F	Z	Z
119	Cu+Sn	W	F	Z	Z
120	Cu+Si	Cu+Si	FGED	FTIRD	Z
121	Cu+Si	Cu+Ni	FGED	FTIRD	Z
122	Cu+Si	Cu	FGED	FTIRD	Z
123	Cu+Si	Cu+Zn+Ni	FGED	FTIRD	Z
124	Cu+Si	GCI	FGE	Z	Z
125	Cu+Si	MCI	FGE	Z	Z
126	Cu+Si	Cm	FGC	Z	Z
127	Cu+Si	Nb OR Cb	F	Z	Z
128	Cu+Si	Gp	J	Z	Z
129	Cu+Si	Mo	F	Z	Z
130	Cu+Si	Ni	FGE	Z	Z
131	Cu+Si	Ni+Cu	FGE	Z	Z
132	Cu+Si	Ni+Cr+Fe	FGE	Z	Z
133	Cu+Si	Nm	FGE	Z	Z
134	Cu+Si	AS	FGE	Z	Z
135	Cu+Si	CS	FGE	Z	Z
136	Cu+Si	LCS	FGE	Z	Z
137	Cu+Si	MCS	FGE	Z	Z
138	Cu+Si	HCS	FGE	Z	Z
139	Cu+Si	SS	FG	Z	Z

140	Cu+Si	TS	FGEH	Z	Z
141	Cu+Si	Ta	F	Z	Z
142	Cu+Si	Ti	F	Z	Z
143	Cu+Si	Tial	F	Z	Z
144	Cu+Si	W	F	Z	Z
145	Cu+Ni	Cu+Ni	FGED	FTIRD	Z
146	Cu+Ni	Cu+Zn+Ni	FGED	FTIRD	Z
147	Cu+Ni	Cu	FGED	FTIRD	Z
148	Cu+Ni	GCI	FGE	Z	Z
149	Cu+Ni	MCI	FGE	Z	Z
150	Cu+Ni	Cm	FGC	Z	Z
151	Cu+Ni	Nb OR Cb	F	Z	Z
152	Cu+Ni	Gp	J	Z	Z
153	Cu+Ni	Mo	F	Z	Z
154	Cu+Ni	Ni	FGE	Z	Z
155	Cu+Ni	Ni+Cu	FGE	Z	Z
156	Cu+Ni	Ni+Cr+Fe	FGE	Z	Z
157	Cu+Ni	Nm	FGE	Z	Z
158	Cu+Ni	AS	FGE	Z	Z
159	Cu+Ni	CS	FGE	Z	Z
160	Cu+Ni	LCS	FGE	Z	Z
161	Cu+Ni	MCS	FGE	Z	Z
162	Cu+Ni	HCS	FGE	Z	Z
163	Cu+Ni	SS	FG	Z	Z
164	Cu+Ni	TS	FGEH	Z	Z
165	Cu+Ni	Ta	F	Z	Z
166	Cu+Ni	Tial	F	Z	Z
167	Cu+Ni	Ti	F	Z	Z
168	Cu+Ni	W	F	Z	Z
169	Cu+Zn+Ni	Cu+Zn+Ni	FD	FTIRD	Z
170	Cu+Zn+Ni	Cu	FGED	FTIRD	Z
171	Cu+Zn+Ni	GCI	FGE	Z	Z
172	Cu+Zn+Ni	MCI	FGE	Z	Z
173	Cu+Zn+Ni	Cm	FGC	Z	Z
174	Cu+Zn+Ni	Nb OR Cb	F	Z	Z
175	Cu+Zn+Ni	Gp	J	Z	Z
176	Cu+Zn+Ni	Mo	F	Z	Z
177	Cu+Zn+Ni	Ni	FGE	Z	Z
178	Cu+Zn+Ni	Ni+Cu	FGE	Z	Z
179	Cu+Zn+Ni	Ni+Cr+Fe	FGE	Z	Z
180	Cu+Zn+Ni	Nm	FGE	Z	Z
181	Cu+Zn+Ni	AS	FGE	Z	Z
182	Cu+Zn+Ni	CS	FGE	Z	Z
183	Cu+Zn+Ni	LCS	FGE	Z	Z
184	Cu+Zn+Ni	MCS	FGE	Z	Z
185	Cu+Zn+Ni	HCS	FGE	Z	Z
186	Cu+Zn+Ni	SS	FG	Z	Z
187	Cu+Zn+Ni	TS	FGEH	Z	Z
188	Cu+Zn+Ni	Ta	F	Z	Z
189	Cu+Zn+Ni	Ti	F	Z	Z
190	Cu+Zn+Ni	Tial	F	Z	Z
191	Cu+Zn+Ni	W	F	Z	Z
192	Cu	Cu	FGED	FTIRD	Z
193	Cu	GCI	FGE	Z	Z
194	Cu	MCI	FGE	Z	Z
195	Cu	Cm	FGC	Z	Z
196	Cu	Nb OR Cb	F	Z	Z
197	Cu	Gp	J	Z	Z
198	Cu	Mo	F	Z	Z
199	Cu	Ni	FGE	Z	Z
200	Cu	Ni+Cu	FGE	Z	Z
201	Cu	Ni+Cr+Fe	FGE	Z	Z
202	Cu	Nm	FGE	Z	Z
203	Cu	AS	FGE	Z	Z
204	Cu	CS	FGE	Z	Z
205	Cu	LCS	FGE	Z	Z
206	Cu	MCS	FGE	Z	Z
207	Cu	HCS	FGE	Z	Z
208	Cu	SS	FG	Z	Z
209	Cu	TS	FGEH	Z	Z
210	Cu	Ta	F	Z	Z
211	Cu	Ti	F	Z	Z

212	Cu		Tial	F	Z	Z
213	Cu		W	F	Z	Z
214	GCI		GCI	FGE	RN	Z
215	GCI		MCI	FGE	RN	Z
216	GCI		Nb OR Cb	FCH	Z	Z
217	GCI		Mo	FCH	Z	Z
218	GCI		Ni	FCE	Z	Z
219	GCI		Ni+Cu	FCE	Z	Z
220	GCI		Ni+Cr+Fe	FCE	Z	Z
221	GCI		Nm	FCE	Z	Z
222	GCI		AS	FE	Z	Z
223	GCI		CS	FE	Z	Z
224	GCI		LCS	FE	Z	Z
225	GCI		MCS	FE	Z	Z
226	GCI		HCS	FE	Z	Z
227	GCI		SS	FGCH	Z	Z
228	GCI		TS	FGEH	Z	Z
229	GCI		Ta	FCH	Z	Z
230	GCI		W	FCH	Z	Z
231	GCI		Ti	F	Z	Z
232	GCI		Tial	F	Z	Z
233	GCI		V	FH	Z	Z
234	GCI		Zr	FH	Z	Z
235	GCI		Hf	FH	Z	Z
236	MCI		MCI	FHE	RN	Z
237	MCI		Nb OR Cb	FHC	Z	Z
238	MCI		Mo	FHC	Z	Z
239	MCI		Ta	FHC	Z	Z
240	MCI		W	FHC	Z	Z
241	MCI		Ni	FEC	Z	Z
242	MCI		Ni+Cu	FEC	Z	Z
243	MCI		Ni+Cr+Fe	FEC	Z	Z
244	MCI		Nm	FEC	Z	Z
245	MCI		AS	FE	Z	Z
246	MCI		CS	FE	Z	Z
247	MCI		LCS	FE	Z	Z
248	MCI		MCS	FE	Z	Z
249	MCI		HCS	FE	Z	Z
250	MCI		SS	FCGH	Z	Z
251	MCI		TS	FEGH	Z	Z
252	MCI		Ti	F	Z	Z
253	MCI		Tial	F	Z	Z
254	MCI		V	FH	Z	Z
255	MCI		Zr	FH	Z	Z
256	MCI		Hf	FH	Z	Z
257	Cm		Cm	KJ	FI	Z
258	Cm		Ni	KL	Z	Z
259	Cm		Ni+Cu	KL	Z	Z
260	Cm		Ni+Cr+Fe	KL	Z	Z
261	Cm		Nm	KL	Z	Z
262	Cm		Ti	F	Z	Z
263	Cm		Tial	F	Z	Z
264	Cm		V	F	Z	Z
265	Cm		Zr	F	Z	Z
266	Cm		Hf	F	Z	Z
267	Nb OR Cb		Nb OR Cb	NO	Z	Z
268	Nb OR Cb		Gp	J	Z	Z
269	Nb OR Cb		Ni	FHC	Z	Z
270	Nb OR Cb		Ni+Cu	FHC	Z	Z
271	Nb OR Cb		Ni+Cr+Fe	FHC	Z	Z
272	Nb OR Cb		Nm	FHC	Z	Z
273	Nb OR Cb		AS	FHC	Z	Z
274	Nb OR Cb		CS	FHC	Z	Z
275	Nb OR Cb		LCS	FHC	Z	Z
276	Nb OR Cb		MCS	FHC	Z	Z
277	Nb OR Cb		HCS	FHC	Z	Z
278	Nb OR Cb		SS	FHC	Z	Z
279	Au		Au	G	Z	Z
280	Gp		Gp	J	FI	Z
281	Gp		Mo	K	Z	Z
282	Gp		AS	Y	Z	Z
283	Gp		CS	Y	Z	Z

284	Gp	SS	Y	Z	Z
285	Gp	LCS	Y	Z	Z
286	Gp	MCS	Y	Z	Z
287	Gp	HCS	Y	Z	Z
288	Gp	Ta	L	Z	Z
289	Gp	Ti	M	Z	Z
290	Gp	Tial	M	Z	Z
291	Gp	W	Z	Z	Z
292	Gp	V	Z	Z	Z
293	Gp	Zr	M	Z	Z
294	Gp	Hf	Z	Z	Z
295	Mg	Mg	B	DFT	Z
296	Mo	Mo	PQCF	TFIR	Z
297	Mo	Ni	FCH	Z	Z
298	Mo	Ni+Cu	FHC	Z	Z
299	Mo	Ni+Cr+Fe	FCH	Z	Z
300	Mo	Nm	FCH	Z	Z
301	Mo	AS	FCH	Z	Z
302	Mo	CS	FCH	Z	Z
303	Mo	LCS	FCH	Z	Z
304	Mo	MCS	FCH	Z	Z
305	Mo	HCS	FCH	Z	Z
306	Mo	SS	FCH	Z	Z
307	Ni	Ni	FGCH	TFIR	D
308	Ni	Ni+Cu	FGCH	TFIR	D
309	Ni	Ni+Cr+Fe	FGCH	TFIR	D
310	Ni	Nm	FGCH	TFIR	D
311	Ni	AS	FGCHE	Z	Z
312	Ni	CS	FGCHE	Z	Z
313	Ni	LCS	FGCHE	Z	Z
314	Ni	MCS	FGCHE	Z	Z
315	Ni	HCS	FGCHE	Z	Z
316	Ni	SS	FGCH	Z	Z
317	Ni	TS	FGCHE	Z	Z
318	Ni	Ta	FCH	Z	Z
319	Ni	Ti	F	Z	Z
320	Ni	Tial	F	Z	Z
321	Ni	W	FCH	Z	Z
322	Ni	V	FH	Z	Z
323	Ni	Zr	FH	Z	Z
324	Ni	Hf	FH	Z	Z
325	Ni+Cu	Ni+Cu	FGCH	TFIR	D
326	Ni+Cu	Ni+Cr:Fe	FGCH	TFIR	D
327	Ni+Cu	Nm	FGCH	TFIR	D
328	Ni+Cu	AS	FGCHE	Z	Z
329	Ni+Cu	CS	FGCHE	Z	Z
330	Ni+Cu	LCS	FGCHE	Z	Z
331	Ni+Cu	MCS	FGCHE	Z	Z
332	Ni+Cu	HCS	FGCHE	Z	Z
333	Ni+Cu	TS	FGCHE	Z	Z
334	Ni+Cu	SS	FGCH	Z	Z
335	Ni+Cu	Ta	FCH	Z	Z
336	Ni+Cu	W	FCH	Z	Z
337	Ni+Cu	Ti	F	Z	Z
338	Ni+Cu	Tial	F	Z	Z
339	Ni+Cu	V	FH	Z	Z
340	Ni+Cu	Zr	FH	Z	Z
341	Ni+Cu	Hf	FH	Z	Z
342	Ni+Cr+Fe	Ni+Cr:Fe	FGCH	TFIR	D
343	Ni+Cr+Fe	Nm	FGCH	TFIR	D
344	Ni+Cr+Fe	AS	FGCHE	Z	Z
345	Ni+Cr+Fe	CS	FGCHE	Z	Z
346	Ni+Cr+Fe	LCS	FGCHE	Z	Z
347	Ni+Cr+Fe	MCS	FGCHE	Z	Z
348	Ni+Cr+Fe	HCS	FGCHE	Z	Z
349	Ni+Cr+Fe	TS	FGCHE	Z	Z
350	Ni+Cr+Fe	SS	FGCH	Z	Z
351	Ni+Cr+Fe	Ta	FCH	Z	Z
352	Ni+Cr+Fe	W	FCH	Z	Z
353	Ni+Cr+Fe	Ti	F	Z	Z
354	Ni+Cr+Fe	Tial	F	Z	Z
355	Ni+Cr+Fe	V	FH	Z	Z

356	Ni+Cr+Fe	Zr	FH	Z	Z
357	Ni+Cr+Fe	Hf	FH	Z	Z
358	Nm	Nm	FGCH	TFIR	D
359	Nm	AS	FGCHE	Z	Z
360	Nm	CS	FGCHE	Z	Z
361	Nm	LCS	FGCHE	Z	Z
362	Nm	MCS	FGCHE	Z	Z
363	Nm	HCS	FGCHE	Z	Z
364	Nm	TS	FGCHE	Z	Z
365	Nm	SS	FGCH	Z	Z
366	Nm	Ta	FCH	Z	Z
367	Nm	W	FCH	Z	Z
368	Nm	Ti	F	Z	Z
369	Nm	Tial	F	Z	Z
370	Nm	V	FH	Z	Z
371	Nm	Zr	FH	Z	Z
372	Nm	Hf	FH	Z	Z
373	Ag	Ag	F	Z	Z
374	Co	Co	I	Z	Z
375	AS	AS	FGCHE	TDFINR	Z
376	AS	CS	FGCHE	TDFINR	Z
377	AS	LCS	FGCHE	TDFINR	Z
378	AS	MCS	FGCHE	TDFINR	Z
379	AS	HCS	FGCHE	TDFINR	Z
380	AS	TS	FGCHE	TDFINR	Z
381	AS	SS	FGCH	F	RID
382	AS	Ta	FCH	Z	Z
383	AS	W	FCH	Z	Z
384	AS	Ti	F	Z	Z
385	AS	Tial	F	Z	Z
386	AS	V	F	Z	Z
387	AS	Zr	F	Z	Z
388	AS	Hf	Z	Z	Z
389	CS	CS	FGCHE	TDFINR	Z
390	CS	LCS	FGCHE	TDFINR	Z
391	CS	MCS	FGCHE	TDFINR	Z
392	CS	HCS	FGCHE	TDFINR	Z
393	CS	TS	FGCHE	TDFINR	Z
394	CS	SS	FGCH	F	RID
395	CS	Ta	FCH	Z	Z
396	CS	W	FCH	Z	Z
397	CS	Ti	F	Z	Z
398	CS	Tial	F	Z	Z
399	CS	V	F	Z	Z
400	CS	Zr	F	Z	Z
401	CS	Hf	Z	Z	Z
402	LCS	LCS	FGCHE	TDFINR	Z
403	LCS	MCS	FGCHE	TDFINR	Z
404	LCS	HCS	FGCHE	TDFINR	Z
405	LCS	TS	FGCHE	TDFINR	Z
406	LCS	SS	FGCH	F	RID
407	LCS	Ta	FCH	Z	Z
408	LCS	Ti	F	Z	Z
409	LCS	Tial	F	Z	Z
410	LCS	W	FCH	Z	Z
411	LCS	V	F	Z	Z
412	LCS	Zr	F	Z	Z
413	LCS	Hf	Z	Z	Z
414	MCS	MCS	FGCHE	TDFINR	Z
415	MCS	HCS	FGCHE	TDFINR	Z
416	MCS	TS	FGCHE	TDFINR	Z
417	MCS	SS	FGCH	F	RID
418	MCS	Ta	FCH	Z	Z
419	MCS	Ti	F	Z	Z
420	MCS	Tial	F	Z	Z
421	MCS	W	FCH	Z	Z
422	MCS	V	F	Z	Z
423	MCS	Zr	F	Z	Z
424	MCS	Hf	Z	Z	Z
425	HCS	HCS	FGCHE	TDFINR	Z
426	HCS	TS	FGCHE	TDFINR	Z
427	HCS	SS	FGCH	F	RID

428	HCS	Ta	FCH	Z	Z
429	HCS	W	FCH	Z	Z
430	HCS	Ti	F	Z	Z
431	HCS	Tial	F	Z	Z
432	HCS	V	F	Z	Z
433	HCS	Zr	F	Z	Z
434	HCS	Hf	Z	Z	Z
435	SS	SS	FGCH	F	RID
436	SS	TS	FGCH	F	RID
437	SS	Ta	FCH	Z	Z
438	SS	W	FCH	Z	Z
439	SS	Ti	F	Z	Z
440	SS	Tial	F	Z	Z
441	SS	V	FH	Z	Z
442	SS	Zr	FH	Z	Z
443	SS	Hf	Z	Z	Z
444	Ta	Ta	RST	F	Z
445	TS	TS	FGCHE	F	RID
446	Ti	V	FH	FI	Z
447	Ti	Zr	FH	FI	Z
448	Ti	Hf	FH	FI	Z
449	Ti	Ti	UVS	FI	Z
450	Ti	Tial	UVS	FI	Z
451	Tial	V	FH	FI	Z
452	Tial	Zr	FH	FI	Z
453	Tial	Hf	FH	FI	Z
454	Tial	Tial	UVS	FI	Z
455	W	W	FGHW	ITFR	Z
456	Zr	Zr	T	Z	Z

BRAZPARA.DBF (Other welding parameters for brazing)

Fields name → / Records ↓	Filler material code (Fill_matl)	Lower current (Joint_I_L)	Upper current (Joint_I_U)	Lower temperature (Braz_T_L)	Upper temperature (Braz_T_U)	Specification (Flux_AWSsp)
1	A	0.006	0.024	1060	1150	FB1A , FB1B , FB1C
2	B	0.004	0.010	1080	1160	FB2A
3	C	0.000	0.002	2000	2100	FB3D , FB3I , FB3J
4	D	0.001	0.005	1275	1700	FB4A,FB3A,FB3C,B3E,B3F,B3G
5	E	0.002	0.005	1670	1800	FB3D,FB3I,FB3J,FB3K
6	F	0.001	0.005	1205	1800	FB4A,FB3D,FB3I,FB3J,FB3C,B3E,B3G,B3H
7	G	0.001	0.005	1635	2250	FB3D,FB3I,FB3J
8	H	0.001	0.005	1700	2200	FB3D,FB3I,FB3J
9	I	0.001	0.005	2100	2500	FB3D,FB3I,FB3J
10	J	0.001	0.005	1830	2000	NO INFORMATION
11	K	0.001	0.005	2460	2550	NO INFORMATION
12	L	0.001	0.005	2600	2700	NO INFORMATION
13	M	0.001	0.005	1840	1900	NO INFORMATION
14	N	0.001	0.005	3300	3400	NO INFORMATION
15	O	0.001	0.005	3200	3500	NO INFORMATION
16	P	0.001	0.005	3450	3550	NO INFORMATION
17	Q	0.001	0.005	3450	3550	NO INFORMATION
18	R	0.001	0.005	3800	3950	NO INFORMATION
19	S	0.001	0.005	1830	1950	NO INFORMATION
20	T	0.001	0.005	1950	2000	NO INFORMATION
21	U	0.001	0.005	1650	1675	NO INFORMATION
22	V	0.001	0.005	1600	1700	NO INFORMATION
23	W	0.001	0.005	1200	1300	NO INFORMATION

SOLDERING.DBF (Welding parameters for soldering)

Fields name → / Records ↓	1st matl (Material1)	2nd matl (Material2)	Solderability (Solderability)	Preplating (Preplating)	Solder (Solder)
1	LCS	LCS	DIFFICULT TO SOLDER	N	ASTM 40 - Sn+Pb
2	LCS	LCS	DIFFICULT TO SOLDER	N	ASTM 20 - Sn+Pb
3	LCS	LCS	DIFFICULT TO SOLDER	N	ASTM 15 - Sn+Pb
4	MCS	MCS	DIFFICULT TO SOLDER	N	ASTM 40 - Sn+Pb
5	MCS	MCS	DIFFICULT TO SOLDER	N	ASTM 20 - Sn+Pb
6	MCS	MCS	DIFFICULT TO SOLDER	N	ASTM 15 - Sn+Pb
7	HCS	HCS	DIFFICULT TO SOLDER	N	ASTM 40 - Sn+Pb
8	HCS	HCS	DIFFICULT TO SOLDER	N	ASTM 20 - Sn+Pb
9	HCS	HCS	DIFFICULT TO SOLDER	N	ASTM 15 - Sn+Pb
10	TS	TS	DIFFICULT TO SOLDER	N	ASTM 40 - Sn+Pb
11	TS	TS	DIFFICULT TO SOLDER	N	ASTM 20 - Sn+Pb
12	TS	TS	DIFFICULT TO SOLDER	N	ASTM 15 - Sn+Pb
13	AS	AS	DIFFICULT TO SOLDER	N	ASTM 40 - Sn+Pb
14	AS	AS	DIFFICULT TO SOLDER	N	ASTM 20 - Sn+Pb
15	AS	AS	DIFFICULT TO SOLDER	N	ASTM 15 - Sn+Pb
16	GCI	GCI	MOST DIFFICULT TO SOLDER	Y	ASTM 50 - Sn+Pb
17	GCI	GCI	MOST DIFFICULT TO SOLDER	Y	ASTM 60 - Sn+Pb
18	GCI	GCI	MOST DIFFICULT TO SOLDER	Y	ASTM 70 - Sn+Pb
19	MCI	MCI	MOST DIFFICULT TO SOLDER	Y	ASTM 50 - Sn+Pb
20	MCI	MCI	MOST DIFFICULT TO SOLDER	Y	ASTM 60 - Sn+Pb
21	MCI	MCI	MOST DIFFICULT TO SOLDER	Y	ASTM 70 - Sn+Pb
22	SS	SS	VERY DIFFICULT TO SOLDER	N	ASTM 50 - Sn+Pb
23	SS	SS	VERY DIFFICULT TO SOLDER	N	ASTM 60 - Sn+Pb
24	SS	SS	VERY DIFFICULT TO SOLDER	N	ASTM 70 - Sn+Pb
25	SS	SS	VERY DIFFICULT TO SOLDER	N	ASTM 95TA - Sn+Sb
26	Al	Al	VERY DIFFICULT TO SOLDER	N	Sn+Zn (Zn % = 30 TO 95)
27	Al	Al	VERY DIFFICULT TO SOLDER	N	Zn+Cd (Zn % = 30 TO 95)
28	Al	Al	VERY DIFFICULT TO SOLDER	N	Zn+Al (Zn % = 30 TO 95)
29	Al	Al	VERY DIFFICULT TO SOLDER	N	Sn+Pb SOLDER
30	Alal	Alal	VERY DIFFICULT TO SOLDER	N	Sn+Pb SOLDER
31	Alal	Alal	VERY DIFFICULT TO SOLDER	N	Zn+Al (Zn % = 30 TO 95)
32	Alal	Alal	VERY DIFFICULT TO SOLDER	N	Zn+Cd (Zn % = 30 TO 95)
33	Alal	Alal	VERY DIFFICULT TO SOLDER	N	Sn+Zn (Zn % = 30 TO 95)
34	Cu	Cu	EASY TO SOLDER	N	Sn+Pb SOLDER
35	Cu+Zn	Cu+Zn	LESS EASY TO SOLDER	N	Sn+Pb SOLDER
36	Cu+Sn	Cu+Sn	LESS EASY TO SOLDER	N	Sn+Pb SOLDER
37	Cu+Ni	Cu+Ni	LESS EASY TO SOLDER	N	Sn+Pb SOLDER
38	Cu+Zn+Ni	Cu+Zn+Ni	LESS EASY TO SOLDER	N	Sn+Pb SOLDER
39	Cu+Al	Cu+Al	VERY DIFFICULT TO SOLDER	N	Sn+Pb SOLDER
40	Cu+Si	Cu+Si	LESS EASY TO SOLDER	N	Sn+Pb SOLDER

41	Ni	Ni	DIFFICULT TO SOLDER	N	Sn+Pb (Sn % >= 50)
42	Ni+Cu	Ni+Cu	VERY DIFFICULT TO SOLDER	N	Sn+Pb (Sn % >= 50)
43	Ni+Cr+Fe	Ni+Cr+Fe	VERY DIFFICULT TO SOLDER	N	Sn+Pb (Sn % >= 50)
44	Nm	Nm	VERY DIFFICULT TO SOLDER	N	Sn+Pb (Sn % >= 50)
45	Pb	Pb	LESS EASY TO SOLDER	N	ASTM 40C - Sn+Pb
46	Pb	Pb	LESS EASY TO SOLDER	N	ASTM 35C - Sn+Pb
47	Pb	Pb	LESS EASY TO SOLDER	N	INIDIUM BASED SOLDER
48	Zn	Zn	DIFFICULT TO SOLDER	N	Zn+Cd SOLDER (Zn % = 90)
49	Zn	Zn	DIFFICULT TO SOLDER	N	Zn+Al SOLDER
50	Zn	Zn	DIFFICULT TO SOLDER	N	Zn+Sn SOLDER (Zn % = 70)
51	Sn	Sn	EASY TO SOLDER	N	Sn+Pb SOLDER (Sn % = 63)
52	Cd	Cd	EASY TO SOLDER	N	ASTM 60 - Sn+Pb
53	Cd	Cd	EASY TO SOLDER	N	ASTM 70 - Sn+Pb
54	Cd	Cd	EASY TO SOLDER	N	INIDIUM BASED (In+Sn)
55	Cm	Cm	MOST DIFFICULT TO SOLDER	Y	In+Sn (In % = 52)
56	Cm	Cm	MOST DIFFICULT TO SOLDER	Y	In+Ag (In % = 97)
57	Cm	Cm	MOST DIFFICULT TO SOLDER	Y	Sn+Pb+Bi BASED
58	Gp	Gp	MOST DIFFICULT TO SOLDER	Y	Sn+Pb+Bi BASED
59	Gp	Gp	MOST DIFFICULT TO SOLDER	Y	In+Ag (In % = 97)
60	Gp	Gp	MOST DIFFICULT TO SOLDER	Y	In+Sn (In % = 52)
61	Au	Au	EASY TO SOLDER	N	Au BASED
62	Ag	Ag	EASY TO SOLDER	N	Pb+Ag SOLDER
63	Pt	Pt	EASY TO SOLDER	N	NO INFORMATION
64	Cr	Cr	MOST DIFFICULT TO SOLDER	Y	NO INFORMATION
65	Rh	Rh	LESS EASY TO SOLDER	N	NO INFORMATION
66	Cc	Cc	MOST DIFFICULT TO SOLDER	Y	NO INFORMATION
67	Pd	Pd	EASY TO SOLDER	N	NO INFORMATION
68	In	In	LESS EASY TO SOLDER	N	INIDIUM BASED
69	Ti	Ti	MOST DIFFICULT TO SOLDER	Y	NO INFORMATION
70	Ta	Ta	MOST DIFFICULT TO SOLDER	Y	NO INFORMATION
71	Mg	Mg	MOST DIFFICULT TO SOLDER	Y	NO INFORMATION

SOLDERING.DBF (Welding parameters for soldering)

Fields name → / Records ↓	Lower soldering temperature (So_temp_L)	Upper soldering temperature (So_temp_U)	Nonactivated flux (Rosin_F_NA)	Midly activated flux (Rosin_F_MA)	Activated flux (Rosin_F_A)	Organic flux (Organic_F)	Inorganic flux (Inorgnic_F)	Special flux (Special_F)
1	455	455	N	N	N	R	R	N
2	535	535	N	N	N	R	R	N
3	553	553	N	N	N	R	R	N
4	455	455	N	N	N	R	R	N
5	535	535	N	N	N	R	R	N
6	553	553	N	N	N	R	R	N
7	455	455	N	N	N	R	R	N
8	535	535	N	N	N	R	R	N
9	553	553	N	N	N	R	R	N
10	455	455	N	N	N	R	R	N
11	535	535	N	N	N	R	R	N
12	553	553	N	N	N	R	R	N
13	455	455	N	N	N	R	R	N
14	535	535	N	N	N	R	R	N
15	553	553	N	N	N	R	R	N
16	421	421	N	N	N	R	R	N
17	374	374	N	N	N	R	R	N
18	378	378	N	N	N	R	R	N
19	421	421	N	N	N	R	R	N
20	374	374	N	N	N	R	R	N
21	378	378	N	N	N	N	R	N
22	421	421	N	N	N	N	R	N
23	374	374	N	N	N	N	R	N
24	378	378	N	N	N	N	R	N
25	464	464	N	N	N	N	N	R
26	592	708	N	N	N	N	N	R
27	635	750	N	N	N	N	N	R
28	720	720	N	N	N	N	N	R
29	421	596	N	N	N	N	N	R
30	421	596	N	N	N	N	N	R
31	720	720	N	N	N	N	N	R

32	635	750	N	N	N	N	R
33	592	708	N	N	N	N	R
34	421	596	R	R	R	R	N
35	421	596	N	N	R	R	N
36	421	596	N	N	R	R	N
37	421	596	N	N	R	R	N
38	421	596	N	N	R	R	N
39	421	596	N	N	R	R	N
40	421	596	N	N	R	R	N
41	421	596	N	N	R	R	N
42	421	596	N	N	R	R	N
43	421	596	N	N	R	R	N
44	421	596	N	N	R	R	N
45	448	448	N	N	R	R	N
46	470	470	N	N	R	R	N
47	290	450	N	N	R	R	N
48	750	750	N	N	R	R	N
49	720	720	N	N	R	R	N
50	708	708	N	N	R	R	N
51	370	378	R	R	R	R	N
52	374	374	R	R	R	R	N
53	378	378	R	R	R	R	N
54	300	400	R	R	R	R	N
55	250	257	N	N	R	R	N
56	100	150	N	N	R	R	N
57	158	255	N	N	R	R	N
58	158	255	N	N	R	R	N
59	100	150	N	N	R	R	N
60	250	257	N	N	R	R	N
61	536	905	R	R	R	R	N
62	579	579	R	R	R	R	N
63	0	0	R	R	R	R	N
64	0	0	R	N	R	R	N
65	0	0	N	N	R	R	N
66	0	0	N	N	R	R	N
67	0	0	R	R	R	R	N
68	450	600	N	N	R	R	N
69	0	0	N	N	R	R	N
70	0	0	N	N	R	R	N
71	0	0	N	N	R	R	N

EBW.DBF (Welding parameters for EBW)

Fields name → / Records ↓	Lower (WT_lower)	Upper (WT_upper)	Combination of parameters (Para_comb)
1	0.00	0.25	HIGH BEAM POWER COUPLED WITH HIGH WELDING SPEED OF EXISTING SYSTEM (APPROXIMATELY 5 OR 6 KW OF POWER WITH 120 INCH / MIN)
2	0.00	100.00	MINIMUM OF HEAT INPUT ENERGY THAT COMBINES HIGH POWER DENSITY WITH HIGH TOTAL BEAM POWER AT HIGHEST POSSIBLE WELDING SPEED

LBW.DBF (Welding parameters for LBW)

Fields name → / Records ↓	Lower (WT_lower)	Upper (WT_upper)	Lower (Power_L)	Upper (Power_U)	Type of Laser (Laser_type)	Gas system (Gas_flow_s)	Diameter of beam (Beam_dia)	Characteristics of beam (Beam_char)
1	0.00	0.10	0.75	2.00	CARBON DIOXIDE	FAST AXIAL FLOW	0.5	PULSED TYPE
2	0.00	0.10	0.75	2.00	CARBON DIOXIDE	GAS TRANSPORT	2.7	CONTINUOUS TYPE
3	0.00	0.10	0.75	2.00	YAG-SOLID STATE	NO	0.0	CONTINUOUS TYPE
4	0.10	0.20	1.25	3.50	CARBON DIOXIDE	FAST AXIAL FLOW	0.5	PULSED TYPE
5	0.10	0.20	1.25	3.50	CARBON DIOXIDE	GAS TRANSPORT	2.7	CONTINUOUS TYPE
6	0.10	0.20	1.25	3.50	YAG-SOLID STATE	NO	0.0	CONTINUOUS TYPE
7	0.20	0.30	1.70	4.75	CARBON DIOXIDE	GAS TRANSPORT	2.7	CONTINUOUS TYPE
8	0.20	0.30	1.70	4.75	YAG-SOLID STATE	NO	0.0	CONTINUOUS TYPE
9	0.30	0.40	3.00	7.50	CARBON DIOXIDE	GAS TRANSPORT	2.7	CONTINUOUS TYPE
10	0.40	0.50	4.00	10.00	CARBON DIOXIDE	GAS TRANSPORT	2.7	CONTINUOUS TYPE
11	0.50	0.60	6.00	16.00	CARBON DIOXIDE	GAS TRANSPORT	2.7	CONTINUOUS TYPE
12	0.60	0.70	8.00	20.00	CARBON DIOXIDE	GAS TRANSPORT	2.7	CONTINUOUS TYPE
13	0.70	0.80	12.00	23.00	CARBON DIOXIDE	GAS TRANSPORT	2.7	CONTINUOUS TYPE

USW.DBF (Welding parameters for USW)

Fields name → / Records ↓	Material (Motation1)	Material (Motation2)	Thickness (WT_inch)	Power (MCpower_w)	Force (Force_L)	Force (Force_U)
1	Al	Al	0.013	300	5	180
2	Al	Al	0.020	450	90	250
3	Al	Al	0.030	750	80	500
4	Al	Al	0.040	1000	60	500
5	Al	Al	0.050	1300	70	700
6	Al	Al	0.060	1750	100	1000
7	Al	Al	0.070	2200	125	1500
8	Al	Al	0.080	2600	150	2000
9	Al	Al	0.100	4200	270	3500
10	Alal	Alal	0.010	400	30	250
11	Alal	Alal	0.020	900	50	500
12	Alal	Alal	0.030	1500	100	700
13	Alal	Alal	0.040	2050	125	1500
14	Alal	Alal	0.050	2800	150	2500
15	Alal	Alal	0.060	3800	200	3000
16	Alal	Alal	0.070	4600	275	3500
17	Cu	Cu	0.010	600	70	400
18	Cu	Cu	0.020	1100	50	550
19	Cu	Cu	0.030	1800	80	700
20	Cu	Cu	0.040	2600	125	1500
21	Cu	Cu	0.050	4000	250	3200
22	SS	SS	0.005	800	80	550
23	SS	SS	0.010	1200	60	600
24	SS	SS	0.020	2600	150	2000
25	SS	SS	0.025	3500	200	2700
26	SS	SS	0.030	4000	250	3200
27	SS	SS	0.035	4400	300	3200

FRW.DBF (Welding parameters for FRW)

ls_name ▶ ds ▼	1st matl. Notation (Notation1)	2nd matl. Notation (Notation2)	Wheel Speed (Sspeed_rpm)	Axial Force (Axforce_lb)	Flywheel (Size) (Fwheel_siz)
1	LCS	LCS	4600	12000	6.7
2	MCS	MCS	4600	14000	7.8
3	AS	AS	4600	15000	8.3
4	Ni+Cr+Fe	Ni+Cr+Fe	1500	50000	130.0
5	SS	SS	3000	18000	20.0
6	SS	SS	3500	18000	14.0
7	Cu	Cu	8000	5000	1.0
8	Cu+Zn	Cu+Zn	7000	5000	1.2
9	Tial	Tial	6000	8000	1.7
10	Alal	Alal	5700	6000	2.7
11	Alal	Alal	5700	7000	3.0
12	Cu	LCS	8000	5000	1.4
13	TS	MCS	3000	40000	27.0
14	SS	LCS	3000	18000	20.0
15	HCS	LCS	4600	12000	8.3
16	Alal	SS	5500	5000	3.9
17	Cu	Alal	2000	7500	11.0

CAH.DBF (Welding parameters for CAH)

Fields name → / Records ↓	Thickness (MT_inch)	Current (Curr1_amps)	Current (Curru_amps)	Polarity (Polarity)	Lower Area (Area_l)	Upper Area (Area_u)	Lower dia. (Elec1_dia_in)	Upper dia. (Elecu_dia_in)	Lower dia. (Pad1_dia_in)	Upper dia. (Padu_dia_in)
1	0.0500	125	225	DCEN(SP)	20	30	0.1875	0.2500	0.1250	0.1250
2	0.1250	175	350	DCEN(SP)	25	35	0.2500	0.3125	0.1250	0.1875
3	0.1875	200	400	DCEN(SP)	30	40	0.2500	0.3125	0.1875	0.2500
4	0.2500	250	400	DCEN(SP)	35	45	0.3125	0.3125	0.2500	0.3300
5	0.3125	300	450	DCEN(SP)	35	45	0.3125	0.3750	0.3300	0.3300
6	0.3750	350	500	DCEN(SP)	35	50	0.3125	0.3750	0.2500	0.3750
7	0.5000	400	600	DCEN(SP)	35	60	0.3125	0.3750	0.3750	0.3750
8	0.7500	600	800	DCEN(SP)	40	60	0.3750	0.3750	0.3125	0.0000

ESH.DBF (Welding parameters for ESH)

Fields name → / Records ↓	Thickness (MT_inch)	Number of electrodes (No_elec)	Dia. code (Dia_code)	Space between elec (Space_elec)	Total current (To_current)	Polarity (Polarity)	Voltage (Voltage)	Oscillation (Osci)	Oscillation speed (Osci_speed)	Oscillation stroke (Osci_stroke)	Dwell time (Dwell_time)
1	0.6250	1	0.1250	0.0000	300	DCEP(RP)	35	N	0.0	0.0000	0
2	1.0000	1	0.1250	0.0000	350	DCEP(RP)	40	N	0.0	0.0000	0
3	2.0000	1	0.1250	0.0000	450	DCEP(RP)	43	N	0.0	0.0000	0
4	2.5000	1	0.1250	0.0000	575	DCEP(RP)	44	Y	24.0	1.6000	2
5	3.0000	1	0.1250	0.0000	675	DCEP(RP)	47	Y	24.0	2.4000	2
6	3.0000	1	0.1250	0.0000	700	DCEP(RP)	52	N	0.0	0.0000	0
7	3.0000	2	0.1250	2.5000	850	DCEP(RP)	40	N	0.0	0.0000	0
8	4.0000	1	0.1250	0.0000	700	DCEP(RP)	43	Y	65.0	3.2500	2
9	4.0000	2	0.1250	2.5000	850	DCEP(RP)	43	N	0.0	0.0000	0
10	5.0000	1	0.1250	0.0000	700	DCEP(RP)	46	Y	85.0	4.2500	2
11	5.0000	2	0.1250	2.5000	850	DCEP(RP)	46	N	0.0	0.0000	0
12	5.0000	2	0.1250	3.2500	1400	DCEP(RP)	41	Y	20.0	1.0000	2
13	6.0000	2	0.1250	3.2500	1400	DCEP(RP)	42	Y	40.0	2.0000	2
14	6.0000	3	0.1250	2.5000	1500	DCEP(RP)	41	N	0.0	0.0000	0
15	7.0000	3	0.1250	2.5000	1650	DCEP(RP)	45	N	80.0	0.0000	0
16	8.0000	2	0.1250	3.2500	1400	DCEP(RP)	45	Y	80.0	4.0000	2
17	8.0000	3	0.1250	2.7500	1800	DCEP(RP)	49	N	0.0	0.0000	0
18	9.0000	3	0.1250	3.0000	1875	DCEP(RP)	53	N	0.0	0.0000	0
19	10.0000	2	0.1250	3.2500	1400	DCEP(RP)	51	Y	120.0	8.0000	2
20	10.0000	3	0.1250	3.5600	2000	DCEP(RP)	36	Y	55.0	1.7500	3
21	12.0000	2	0.1250	3.2500	1400	DCEP(RP)	51	Y	120.0	8.0000	2
22	12.0000	3	0.1250	4.5000	1800	DCEP(RP)	55	Y	60.0	2.0000	4
23	13.0000	3	0.1250	5.0000	1800	DCEP(RP)	55	Y	75.0	2.5000	4
24	14.0000	3	0.1250	5.2500	1800	DCEP(RP)	55	Y	82.5	2.7500	4
25	15.0000	3	0.1250	5.5000	1800	DCEP(RP)	55	Y	90.0	3.0000	4
26	16.0000	3	0.1250	6.0000	1800	DCEP(RP)	55	Y	105.0	3.5000	4
27	17.0000	3	0.1250	6.2500	1800	DCEP(RP)	55	Y	112.5	3.7500	4
28	18.0000	3	0.1250	6.5000	1800	DCEP(RP)	55	Y	120.0	4.0000	4
29	18.0000	4	0.1250	5.0000	2400	DCEP(RP)	55	Y	75.0	2.0000	4
30	19.0000	4	0.1250	5.2500	2400	DCEP(RP)	55	Y	82.5	2.2500	4
31	20.0000	4	0.1250	5.5000	2400	DCEP(RP)	55	Y	90.0	2.5000	4
32	21.0000	4	0.1250	5.7500	2400	DCEP(RP)	55	Y	97.5	2.7500	4
33	22.0000	4	0.1250	6.0000	2400	DCEP(RP)	55	Y	105.0	3.0000	4
34	23.0000	4	0.1250	6.2500	2400	DCEP(RP)	55	Y	112.5	3.2500	4
35	24.0000	4	0.1250	6.5000	2400	DCEP(RP)	55	Y	120.0	3.5000	4
36	24.0000	4	0.1250	5.0000	2400	DCEP(RP)	55	Y	75.0	3.0000	4
37	25.0000	4	0.1250	5.2500	2400	DCEP(RP)	55	Y	82.5	3.0000	4
38	26.0000	4	0.1250	5.5000	2400	DCEP(RP)	55	Y	90.0	3.0000	4
39	27.0000	4	0.1250	5.7500	2400	DCEP(RP)	55	Y	97.5	3.0000	4
40	28.0000	4	0.1250	6.0000	2400	DCEP(RP)	55	Y	105.0	3.0000	4
41	29.0000	4	0.1250	6.0000	2400	DCEP(RP)	55	Y	112.5	4.0000	4
42	30.0000	4	0.1250	6.2500	2400	DCEP(RP)	55	Y	120.0	4.0000	4
43	30.0000	6	0.1250	5.2500	3600	DCEP(RP)	55	Y	82.5	2.7500	4
44	31.0000	6	0.1250	5.5000	3600	DCEP(RP)	55	Y	90.0	2.5000	4
45	32.0000	6	0.1250	5.6250	3600	DCEP(RP)	55	Y	94.0	2.8750	4
46	33.0000	6	0.1250	5.7500	3600	DCEP(RP)	55	Y	99.5	3.2500	4
47	34.0000	6	0.1250	6.0000	3600	DCEP(RP)	55	Y	105.0	3.0000	4
48	35.0000	6	0.1250	6.1250	3600	DCEP(RP)	55	Y	109.0	3.3750	4
49	36.0000	6	0.1250	6.2500	3600	DCEP(RP)	55	Y	112.5	3.7500	4

SAWPARA.DBF (Welding parameters for SAW)

ati- ion)	Working thickness (WT_inch)	Number of passes (NO_passes)	Polarity (Polarity)	Current (Current)	Voltage (Voltage)	Travel speed (TR_speed)	Dia. of wire (Dia_FW)
	0.18750	1	DCEP(RP)	650	28	48	0.12500
	0.18750	1	DCEP(RP)	650	28	48	0.12500
	0.18750	1	DCEP(RP)	650	28	48	0.12500
	0.18750	1	DCEP(RP)	650	28	48	0.12500
	0.18750	2	DCEP(RP)	350,300	32,29	46,46	0.06250
	0.18750	2	DCEP(RP)	350,300	32,29	46,46	0.06250
	0.18750	2	DCEP(RP)	350,300	32,29	46,46	0.06250
	0.18750	2	DCEP(RP)	350,300	32,29	46,46	0.06250
	0.25000	1	DCEP(RP)	900	33	26	0.18750
	0.25000	1	DCEP(RP)	900	33	26	0.18750
	0.25000	1	DCEP(RP)	900	33	26	0.18750
	0.25000	1	DCEP(RP)	900	33	26	0.18750
	0.25000	2	DCEP(RP)	375,325	33,34	42,42	0.06250
	0.25000	2	DCEP(RP)	375,325	33,34	42,42	0.06250
	0.25000	2	DCEP(RP)	375,325	33,34	42,42	0.06250
	0.25000	2	DCEP(RP)	375,325	33,34	42,42	0.06250
	0.37500	1	DCEP(RP)	950	33	24	0.21875
	0.37500	1	DCEP(RP)	950	33	24	0.21875
	0.37500	1	DCEP(RP)	950	33	24	0.21875
	0.37500	1	DCEP(RP)	950	33	24	0.21875
	0.37500	2	DCEP(RP)	475,425	35,33	28,28	0.07812
	0.37500	2	DCEP(RP)	475,425	35,33	28,28	0.07812
	0.37500	2	DCEP(RP)	475,425	35,33	28,28	0.07812
	0.37500	2	DCEP(RP)	475,425	35,33	28,28	0.07812
	0.50000	1	DCEP(RP)	1100	34	18	0.21875
	0.50000	1	DCEP(RP)	1100	34	18	0.21875
	0.50000	1	DCEP(RP)	1100	34	18	0.21875
	0.50000	1	DCEP(RP)	1100	34	18	0.21875
	0.50000	2	DCEP(RP)	500,475	36,34	21,21	0.07812
	0.50000	2	DCEP(RP)	500,475	36,34	21,21	0.07812
	0.50000	2	DCEP(RP)	500,475	36,34	21,21	0.07812
	0.50000	2	DCEP(RP)	500,475	36,34	21,21	0.07812
	0.62500	2	DCEP(RP)	500,500	37,35	16,16	0.07812
	0.62500	2	DCEP(RP)	500,500	37,35	16,16	0.07812
	0.62500	2	DCEP(RP)	500,500	37,35	16,16	0.07812
	0.62500	2	DCEP(RP)	500,500	37,35	16,16	0.07812
	0.75000	2	DCEP(RP)	960,1100	38,42	12,12	0.18750
	0.75000	2	DCEP(RP)	960,1100	38,42	12,12	0.18750
	0.75000	2	DCEP(RP)	960,1100	38,42	12,12	0.18750
	0.75000	2	DCEP(RP)	960,1100	38,42	12,12	0.18750
	1.00000	2	DCEP(RP)	1200,850	35,35	12,18	0.25000
	1.00000	2	DCEP(RP)	1200,850	35,35	12,18	0.25000
	1.00000	2	DCEP(RP)	1200,850	35,35	12,18	0.25000
	1.00000	2	DCEP(RP)	1200,850	35,35	12,18	0.25000
	1.25000	2	DCEP(RP)	1100,1150	30,30	6.5,6	0.25000
	1.25000	2	DCEP(RP)	1100,1150	30,30	6.5,6	0.25000
	1.25000	2	DCEP(RP)	1100,1150	30,30	6.5,6	0.25000
	1.25000	2	DCEP(RP)	1100,1150	30,30	6.5,6	0.25000
	1.50000	2	DCEP(RP)	1150,1200	30,30	6.5,6	0.25000
	1.50000	2	DCEP(RP)	1150,1200	30,30	6.5,6	0.25000
	1.50000	2	DCEP(RP)	1150,1200	30,30	6.5,6	0.25000
	1.50000	2	DCEP(RP)	1150,1200	30,30	6.5,6	0.25000

SMAWWELD.DBF (Welding technique for SMAW)

Fields name → / Records ↓	(Joint_prep	(Weld_pos)	(Work_angle)	(Travel_angle	(Weld_tech)
1	G	FLAT(1G)	90	5-10	BACKHAND
2	G	HORIZONTAL(2G)	80-100	5-10	BACKHAND
3	G	VERTICAL(3G)	90	5-10	FOREHAND
4	G	OVERHEAD(4G)	90	5-10	BACKHAND
5	F	FLAT(1G)	45	5-10	BACKHAND
6	F	HORIZONTAL(2G)	45	5-10	BACKHAND
7	F	VERTICAL(3G)	35-55	5-10	FOREHAND
8	F	OVERHEAD(4G)	30-45	5-10	BACKHAND

SMAWPARA.DBF (Welding parameters for SMAW)

Fields_name→ / Records ↓	Working thickness (WT_inch)	Number of passes (NO_passes)	Current (Curr_amps)	Voltage (Voltage)	Travel speed (Trav_speed)	Dia of filler (Dia_FM)
1	0.0320	1	20	15	4	0.03200
2	0.0625	1	35	15	9	0.06250
3	0.1250	1	90	17	9	0.12500
4	0.1875	1	120	19	7	0.15625
5	0.2500	1	145	20	5.5	0.15625
6	0.3750	1	155	21	8.5	0.18750
7	0.5000	1	170	22	12	0.18750
8	0.7500	1	195	22	15	0.25000
9	0.7500	2	570,590	35,35	14-16	0.25000
10	1.0000	1	215	22	17.5	0.25000
11	1.0000	2	600,600	37,37	10-12	0.25000
12	2.5000	3	600,800,900	27,28,36	24,24,6-12	0.21900

EGH.DBF (Welding parameters for EGH)

Fields name → / Records ↓	Thickness (WT_inch)	Lowest Current (Currl_amps)	Highest Current (Curru_amps)	Polarity (Polarity)	Lowest Voltage (Voltage_l)	Highest Voltage (Voltage_u)	Electrode Electrode (Elec_feed)
1	0.5000	450	500	DCEP(RP)	35	37	300
2	0.6250	475	525	DCEP(RP)	36	38	340
3	0.7500	525	575	DCEP(RP)	37	39	380
4	1.0000	625	675	DCEP(RP)	40	42	350
5	1.2500	625	675	DCEP(RP)	40	42	350
6	1.5000	625	675	DCEP(RP)	40	42	350

EGH.DBF (Welding parameters for EGH)

Fields name → / Records ↓	Travel Speed (Trav_speed)	Electrode Extension (Elec_ext)	Oscillation distance (Oscl_dist)	Shielding gas (Shield_gas)
1	6.0	2+1/8	N.A.	80% ARGON + 20% CARBON DIOXIDE
2	4.4	2+1/8	N.A.	80% ARGON + 20% CARBON DIOXIDE
3	3.9	2+1/8	N.A.	80% ARGON + 20% CARBON DIOXIDE
4	3.4	3+1/8	N.A.	80% ARGON + 20% CARBON DIOXIDE
5	2.6	3+1/8	N.A.	80% ARGON + 20% CARBON DIOXIDE
6	1.7	3+1/8	3/4	80% ARGON + 20% CARBON DIOXIDE

DFW.DBF (Welding parameters for DFW)

ion1)	(Notation2)	(Fill_mat1)	(DFW_TL_F)	(DFW_TU_F)	(DFW_PL_ksi)	(DFW_PU_ksi)	(DFW_tU_min)	(DFW_tL_min)	(DFW_Atmos)
	Zr	NONE	1000	1000	22.000	50.000	15.00	15.00	VACUUM
	U	Ni PLATE	900	900	5.000	5.000	0.00	0.00	NO INFORMATION
	LCS	NONE	950	950	8.000	8.000	0.50	0.00	VACCUM
	MCS	NONE	950	950	8.000	8.000	0.50	0.00	VACCUM
	HCS	NONE	950	950	8.000	8.000	0.50	0.00	VACCUM
	Ni	NONE	930	930	22.000	52.000	4.00	4.00	VACCUM
	Cu	NONE	880	880	40.000	40.000	4.00	4.00	VACCUM
	Cu	NONE	940	940	1.000	1.000	0.25	0.25	NO INFORMATION
	Cu	NONE	950	950	1.000	1.000	15.00	15.00	VACUUM
	Al	Si	1080	1080	1.000	2.000	1.00	1.00	VACUUM
	Alal	Al	325	325	240.00	240.00	60.00	60.00	ARGON
	CC	Ag	500	500	0.000	0.000	120.00	120.00	AIR
	Tial	Ag	500	500	0.000	0.000	120.00	120.00	AIR
	Tial	NONE	940	940	0.000	0.000	30.00	30.00	VACUUM
	Be	NONE	1500	1650	10.000	10.000	240.00	240.00	INERT
	Be	NONE	1500	1800	0.000	0.000	60.00	60.00	VACUUM
	Be	Ag FOIL	1300	1300	10.000	10.000	10.00	10.00	VACUUM
In	Tial	NONE	900	900	0.000	0.000	480.00	480.00	VACUUM
	Cu	NONE	600	600	20.300	20.300	1.00	1.00	HELIUM
	Ti	NONE	1560	1560	0.700	0.700	15.00	15.00	VACUUM
	Nb OR Cb	NONE	1800	1900	30.000	30.000	30.00	120.00	VACUUM
	SS	NONE	1800	1800	0.000	0.000	120.00	120.00	VACUUM
	W	NONE	1550	1550	0.600	0.600	30.00	30.00	NO INFORMATION
	GCI	NONE	1470	1470	0.510	0.510	10.00	10.00	VACUUM
	MCI	NONE	1470	1470	0.510	0.510	10.00	10.00	VACUUM
	MCI	NONE	1470	1470	0.510	0.510	10.00	10.00	VACUUM
	Cr	NONE	2100	2100	10.000	10.000	180.00	180.00	NO INFORMATION
OR Cb	Ta	ZIRCONIUM	1600	1600	5.000	5.000	30.00	30.00	NO INFORMATION
OR Cb	SS	IRON	1500	2300	2.000	2.000	30.00	30.00	NO INFORMATION
OR Cb	SS	NONE	2000	2000	1.400	1.400	20.00	20.00	NO INFORMATION
OR Cb	Mo	NONE	2550	2550	0.700	0.700	10.00	10.00	NO INFORMATION
OR Cb	Nb OR Cb	NONE	2100	2400	10.000	10.000	180.00	180.00	INERT
OR Cb	Nb OR Cb	ZIRCONIUM	1540	1540	10.000	10.000	240.00	240.00	ARGON
OR Cb	Nb OR Cb	INIDIUM	2000	2000	0.130	0.130	60.00	60.00	VACUUM
	W	NONE	3630	3630	1.400	1.400	10.00	10.00	NO INFORMATION
	SS	NONE	2000	2000	1.400	1.400	20.00	20.00	NO INFORMATION
	SS	Ni	1500	2300	2.000	2.000	30.00	30.00	NO INFORMATION
	Mo	NONE	2300	2600	10.000	10.000	180.00	180.00	INERT
	Mo	NONE	2910	2910	1.400	1.400	20.00	20.00	VACUUM
	Mo	Ti FOIL	1700	1700	10.000	10.000	120.00	120.00	ARGON
	Mo	Ti FOIL	1600	1600	12.500	12.500	10.00	10.00	VACUUM
Cu	Ni+Cu	NONE	650	650	1.500	6.000	180.00	180.00	ARGON
Cr+Fe	Ni+Cr+Fe	NONE	2000	2100	0.500	0.500	10.00	10.00	VACUUM
Cr+Fe	SS	NONE	1620	1620	0.000	0.000	15.00	15.00	VACUUM
Cr+Fe	SS	Ag	600	600	0.000	0.000	30.00	30.00	AIR
Cr+Fe	SS	Ni	1320	1320	0.000	0.000	30.00	30.00	VACUUM
Cr+Fe	Tial	NONE	1320	1320	0.000	0.000	10.00	10.00	VACUUM
Cr+Fe	Tial	Ag	700	700	0.000	0.000	30.00	30.00	AIR
	Nm	Ni	2020	2020	4.000	4.000	20.00	20.00	ARGON
	Ni	Ni	2000	2000	9.000	9.000	45.00	45.00	VACUUM
	Ni	NONE	1600	1600	24.000	24.000	0.30	0.30	ARGON
	Pd	NONE	1100	1200	3.000	3.500	8.00	8.00	VACUUM
	LCS	NONE	2000	2000	0.500	0.500	10.00	10.00	VACUUM
	Zr	NONE	1900	1900	0.000	0.000	3.00	3.00	ARGON
	Zr	NONE	1870	1870	0.000	0.000	80.00	80.00	VACUUM
	Zr	NONE	1870	1870	0.000	0.000	3.00	3.00	HELIUM
	Tial	NONE	1420	1420	0.000	0.000	10.00	10.00	VACUUM
	Tial	Ag	700	700	0.000	0.000	30.00	30.00	AIR
	SS	NONE	2100	2100	10.000	10.000	60.00	180.00	ARGON
	SS	Ni+9%ATOMIC Be	2200	2200	0.001	0.001	5.00	5.00	AIR
	Ta	NONE	2400	2600	10.000	10.000	180.00	180.00	INERT
	Ta	Ti FOIL	1600	1600	10.000	10.000	10.00	10.00	VACUUM
	Ta	ZIRCONIUM	1600	1600	0.000	0.000	0.00	0.00	NO INFORMATION
	Ta	Ta FOIL	2200	2600	10.000	40.000	1.00	1.00	ARGON
	Ta	Ta FOIL	2600	2600	10.000	20.000	0.30	0.30	ARGON
	Ti	NONE	1300	1300	4.000	10.000	10.00	10.00	VACUUM

67	Ti	Ti	NONE	1700	1700	0.500	0.500	10.00	10.00	ARGON
68	Ti	Ti	NONE	1550	1550	10.000	10.000	180.00	240.00	ARGON
69	Ti	Ti	Al FOIL	1050	1050	10.000	10.000	10.00	10.00	VACUUM
70	Tial	Tial	NONE	1700	1700	0.500	0.500	10.00	10.00	ARGON
71	U	Zr	NONE	1550	1550	2.200	2.200	2160.00	2160.00	INERT
72	U	Zr	NONE	1200	1200	10.000	10.000	360.00	360.00	INERT
73	W	W	NONE	2800	2800	0.300	0.500	10.00	10.00	ARGON
74	W	W	Ni+Pd	1800	1800	10.000	10.000	90.00	90.00	HELIUM
75	W	W	Re+Ta	1850	1850	20.000	20.000	30.00	30.00	NO INFORMATION
76	W	W	Cb	1700	1700	10.000	10.000	20.00	20.00	VACUUM
77	Zr	Zr	NONE	1550	1550	10.000	10.000	210.00	210.00	INERT
78	Zr	Zr	Cu	1900	1900	30.000	30.000	30.00	120.00	HELIUM

FCAWPA.DBF (Welding Parameters for fillet Joint of FCAW)

No	Base_name	Rotation	Thickness (MT_inch)	Joint	Joint_prep	Position (Weld_posi)	Type (Process_type)	Number (Number_passes)	Diameter (Dia_in)
1	LCS	0.1250	FILLET	FLAT(1G)		GAS SHIELDED TYPE	1	0.09375
2	LCS	0.1875	FILLET	FLAT(1G)		GAS SHIELDED TYPE	1	0.09375
3	LCS	0.1875	FILLET	FLAT(1G)		GAS SHIELDED TYPE	1	0.12500
4	LCS	0.2500	FILLET	FLAT(1G)		GAS SHIELDED TYPE	1	0.12500
5	LCS	0.2500	FILLET	FLAT(1G)		GAS SHIELDED TYPE	1	0.09375
6	LCS	0.3125	FILLET	FLAT(1G)		GAS SHIELDED TYPE	1	0.09375
7	LCS	0.3125	FILLET	FLAT(1G)		GAS SHIELDED TYPE	1	0.12500
8	LCS	0.3750	FILLET	FLAT(1G)		GAS SHIELDED TYPE	1	0.12500
9	LCS	0.3750	FILLET	FLAT(1G)		GAS SHIELDED TYPE	1	0.09375
10	LCS	0.5000	FILLET	FLAT(1G)		GAS SHIELDED TYPE	2	0.09375
11	LCS	0.5000	FILLET	FLAT(1G)		GAS SHIELDED TYPE	2	0.12500
12	LCS	0.6250	FILLET	FLAT(1G)		GAS SHIELDED TYPE	3	0.12500
13	LCS	0.6250	FILLET	FLAT(1G)		GAS SHIELDED TYPE	3	0.09375
14	LCS	0.7500	FILLET	FLAT(1G)		GAS SHIELDED TYPE	3	0.09375
15	LCS	0.7500	FILLET	FLAT(1G)		GAS SHIELDED TYPE	3	0.12500
16	LCS	0.1250	FILLET	HORIZONTAL(2G)		GAS SHIELDED TYPE	1	0.09375
17	LCS	0.1875	FILLET	HORIZONTAL(2G)		GAS SHIELDED TYPE	1	0.09375
18	LCS	0.1875	FILLET	HORIZONTAL(2G)		GAS SHIELDED TYPE	1	0.12500
19	LCS	0.2500	FILLET	HORIZONTAL(2G)		GAS SHIELDED TYPE	1	0.12500
20	LCS	0.2500	FILLET	HORIZONTAL(2G)		GAS SHIELDED TYPE	1	0.09375
21	LCS	0.3125	FILLET	HORIZONTAL(2G)		GAS SHIELDED TYPE	1	0.09375
22	LCS	0.3125	FILLET	HORIZONTAL(2G)		GAS SHIELDED TYPE	1	0.12500
23	LCS	0.3750	FILLET	HORIZONTAL(2G)		GAS SHIELDED TYPE	1	0.12500
24	LCS	0.3750	FILLET	HORIZONTAL(2G)		GAS SHIELDED TYPE	1	0.09375
25	LCS	0.5000	FILLET	HORIZONTAL(2G)		GAS SHIELDED TYPE	3	0.09375
26	LCS	0.5000	FILLET	HORIZONTAL(2G)		GAS SHIELDED TYPE	3	0.12500
27	LCS	0.6250	FILLET	HORIZONTAL(2G)		GAS SHIELDED TYPE	3	0.12500
28	LCS	0.6250	FILLET	HORIZONTAL(2G)		GAS SHIELDED TYPE	3	0.09375
29	LCS	0.7500	FILLET	HORIZONTAL(2G)		GAS SHIELDED TYPE	6	0.09375
30	LCS	0.7500	FILLET	HORIZONTAL(2G)		GAS SHIELDED TYPE	6	0.12500
31	LCS	0.3750	FILLET	VERTICAL(2G)		GAS SHIELDED TYPE	1	0.04500
32	LCS	0.3125	FILLET	FLAT(1G)		SELF SHIELDED TYPE	1	0.09375
33	MCS	0.3125	FILLET	FLAT(1G)		SELF SHIELDED TYPE	1	0.09375
34	HCS	0.3125	FILLET	FLAT(1G)		SELF SHIELDED TYPE	1	0.09375
35	TS	0.3125	FILLET	FLAT(1G)		SELF SHIELDED TYPE	1	0.09375
36	AS	0.3125	FILLET	FLAT(1G)		SELF SHIELDED TYPE	1	0.09375
37	LCS	1.0000	FILLET	FLAT(1G)		SELF SHIELDED TYPE	4	0.12500
38	MCS	1.0000	FILLET	FLAT(1G)		SELF SHIELDED TYPE	4	0.12500
39	HCS	1.0000	FILLET	FLAT(1G)		SELF SHIELDED TYPE	4	0.12500
40	TS	1.0000	FILLET	FLAT(1G)		SELF SHIELDED TYPE	4	0.12500
41	AS	1.0000	FILLET	FLAT(1G)		SELF SHIELDED TYPE	4	0.12500
42	LCS	0.1050	FILLET	HORIZONTAL(2G)		SELF SHIELDED TYPE	1	0.07813

43	MCS	0.1050	FILLET	HORIZONTAL(2G)	SELF SHIELDED TYPE	1	0.07813
44	HCS	0.1050	FILLET	HORIZONTAL(2G)	SELF SHIELDED TYPE	1	0.07813
45	TS	0.1050	FILLET	HORIZONTAL(2G)	SELF SHIELDED TYPE	1	0.07813
46	AS	0.1050	FILLET	HORIZONTAL(2G)	SELF SHIELDED TYPE	1	0.07813
47	LCS	0.1875	FILLET	HORIZONTAL(2G)	SELF SHIELDED TYPE	1	0.09375
48	MCS	0.1875	FILLET	HORIZONTAL(2G)	SELF SHIELDED TYPE	1	0.09375
49	HCS	0.1875	FILLET	HORIZONTAL(2G)	SELF SHIELDED TYPE	1	0.09375
50	TS	0.1875	FILLET	HORIZONTAL(2G)	SELF SHIELDED TYPE	1	0.09375
51	AS	0.1875	FILLET	HORIZONTAL(2G)	SELF SHIELDED TYPE	1	0.09375
52	LCS	0.2500	FILLET	HORIZONTAL(2G)	SELF SHIELDED TYPE	1	0.09375
53	MCS	0.2500	FILLET	HORIZONTAL(2G)	SELF SHIELDED TYPE	1	0.09375
54	HCS	0.2500	FILLET	HORIZONTAL(2G)	SELF SHIELDED TYPE	1	0.09375
55	TS	0.2500	FILLET	HORIZONTAL(2G)	SELF SHIELDED TYPE	1	0.09375
56	AS	0.2500	FILLET	HORIZONTAL(2G)	SELF SHIELDED TYPE	1	0.09375
57	LCS	1.0000	FILLET	HORIZONTAL(2G)	SELF SHIELDED TYPE	5	0.12500
58	MCS	1.0000	FILLET	HORIZONTAL(2G)	SELF SHIELDED TYPE	5	0.12500
59	HCS	1.0000	FILLET	HORIZONTAL(2G)	SELF SHIELDED TYPE	5	0.12500
60	TS	1.0000	FILLET	HORIZONTAL(2G)	SELF SHIELDED TYPE	5	0.12500
61	AS	1.0000	FILLET	HORIZONTAL(2G)	SELF SHIELDED TYPE	5	0.12500
62	LCS	0.2500	FILLET	VERTICAL(3G)	SELF SHIELDED TYPE	1	0.06250
63	MCS	0.2500	FILLET	VERTICAL(3G)	SELF SHIELDED TYPE	1	0.06250
64	HCS	0.2500	FILLET	VERTICAL(3G)	SELF SHIELDED TYPE	1	0.06250
65	TS	0.2500	FILLET	VERTICAL(3G)	SELF SHIELDED TYPE	1	0.06250
66	AS	0.2500	FILLET	VERTICAL(3G)	SELF SHIELDED TYPE	1	0.06250
67	LCS	0.6250	FILLET	VERTICAL(3G)	SELF SHIELDED TYPE	1	0.06250
68	MCS	0.6250	FILLET	VERTICAL(3G)	SELF SHIELDED TYPE	1	0.06250
69	HCS	0.6250	FILLET	VERTICAL(3G)	SELF SHIELDED TYPE	1	0.06250
70	TS	0.6250	FILLET	VERTICAL(3G)	SELF SHIELDED TYPE	1	0.06250
71	AS	0.6250	FILLET	VERTICAL(3G)	SELF SHIELDED TYPE	1	0.06250
72	LCS	1.5000	FILLET	VERTICAL(3G)	SELF SHIELDED TYPE	4	0.06250
73	MCS	1.5000	FILLET	VERTICAL(3G)	SELF SHIELDED TYPE	4	0.06250
74	HCS	1.5000	FILLET	VERTICAL(3G)	SELF SHIELDED TYPE	4	0.06250
75	TS	1.5000	FILLET	VERTICAL(3G)	SELF SHIELDED TYPE	4	0.06250
76	AS	1.5000	FILLET	VERTICAL(3G)	SELF SHIELDED TYPE	4	0.06250
77	LCS	0.1050	FILLET	OVERHEAD(4G)	SELF SHIELDED TYPE	1	0.06250
78	MCS	0.1050	FILLET	OVERHEAD(4G)	SELF SHIELDED TYPE	1	0.06250
79	HCS	0.1050	FILLET	OVERHEAD(4G)	SELF SHIELDED TYPE	1	0.06250
80	TS	0.1050	FILLET	OVERHEAD(4G)	SELF SHIELDED TYPE	1	0.06250
81	AS	0.1050	FILLET	OVERHEAD(4G)	SELF SHIELDED TYPE	1	0.06250
82	LCS	0.7500	FILLET	OVERHEAD(4G)	SELF SHIELDED TYPE	6	0.06250
83	MCS	0.7500	FILLET	OVERHEAD(4G)	SELF SHIELDED TYPE	6	0.06250
84	HCS	0.7500	FILLET	OVERHEAD(4G)	SELF SHIELDED TYPE	6	0.06250
85	TS	0.7500	FILLET	OVERHEAD(4G)	SELF SHIELDED TYPE	6	0.06250
86	AS	0.7500	FILLET	OVERHEAD(4G)	SELF SHIELDED TYPE	6	0.06250
87	LCS	0.3125	FILLET	OVERHEAD(4G)	SELF SHIELDED TYPE	2	0.06250
88	MCS	0.3125	FILLET	OVERHEAD(4G)	SELF SHIELDED TYPE	2	0.06250
89	HCS	0.3125	FILLET	OVERHEAD(4G)	SELF SHIELDED TYPE	2	0.06250
90	TS	0.3125	FILLET	OVERHEAD(4G)	SELF SHIELDED TYPE	2	0.06250
91	AS	0.3125	FILLET	OVERHEAD(4G)	SELF SHIELDED TYPE	2	0.06250
92	LCS	1.0000	FILLET	OVERHEAD(4G)	SELF SHIELDED TYPE	8	0.06250
93	MCS	1.0000	FILLET	OVERHEAD(4G)	SELF SHIELDED TYPE	8	0.06250
94	HCS	1.0000	FILLET	OVERHEAD(4G)	SELF SHIELDED TYPE	8	0.06250
95	TS	1.0000	FILLET	OVERHEAD(4G)	SELF SHIELDED TYPE	8	0.06250
96	AS	1.0000	FILLET	OVERHEAD(4G)	SELF SHIELDED TYPE	8	0.06250
97	SS	0.3750	FILLET	FLAT(1G)	SELF SHIELDED TYPE	1	0.09375
98	SS	0.7500	FILLET	FLAT(1G)	SELF SHIELDED TYPE	3	0.09375
99	SS	0.1250	FILLET	HORIZONTAL(2G)	SELF SHIELDED TYPE	1	0.06250
100	SS	0.3750	FILLET	HORIZONTAL(2G)	SELF SHIELDED TYPE	1	0.09375

FCAWFIPA.DBF (Welding parameters for fillet joint of FCAW)

PART 11

Fields name → / Records ↓	Polarity (Polarity)	Current (Curr_amps)	Voltage (Voltage	Filler mat (Fm_mat	Travel (Travel_Speed	Gas flow (Gas_flrate)	Filler Extension (Ext_FA)
1	DCEP(RF)	300	25.00	350	53	35	0.00
2	DCEP(RP)	350	25.00	350	41	35	0.00
3	DCEP(RP)	450	25.00	350	40	35	0.00
4	DCEP(RP)	500	26.00	350	25	35	0.00
5	DCEP(RP)	400	26.00	350	24	35	0.00
6	DCEP(RP)	550	29.00	300	22	35	0.00
7	DCEP(RP)	460	27.00	280	20	35	0.00
8	DCEP(RP)	575	30.00	280	20	35	0.00
9	DCEP(RP)	575	30.00	280	20	35	0.00
10	DCEP(RP)	525	31.00	250	16	35	0.00
11	DCEP(RP)	525	31.00	250	16	35	0.00
12	DCEP(RP)	450	30.00	220	14	35	0.00
13	DCEP(RP)	475	30.00	220	12	35	0.00
14	DCEP(RP)	500	30.00	200	13	35	0.00
15	DCEP(RP)	500	30.00	200	12	35	0.00
16	DCEP(RP)	350	25.00	200	60	35	0.00
17	DCEP(RP)	400	25.00	200	41	35	0.00
18	DCEP(RP)	425	25.00	200	32	35	0.00
19	DCEP(RP)	450	26.00	190	25	35	0.00
20	DCEP(RP)	400	25.00	190	32	35	0.00
21	DCEP(RP)	440	26.00	175	20	35	0.00
22	DCEP(RP)	460	27.00	175	20	35	0.00
23	DCEP(RP)	500	27.00	175	14	35	0.00
24	DCEP(RP)	475	27.00	175	15	35	0.00
25	DCEP(RP)	400	25.00	180	20	35	0.00
26	DCEP(RP)	450	26.00	180	18	35	0.00
27	DCEP(RP)	450	28.00	180	14	35	0.00
28	DCEP(RP)	450	27.00	175	14	35	0.00
29	DCEP(RP)	470	29.00	190	20	35	0.00
30	DCEP(RP)	470	29.00	190	20	35	0.00
31	DCEP(RP)	180	21.00	175	4	35	0.00
32	DCEP(RP)	350	30.00	190	00	30-40	2.75
33	DCEP(RP)	350	30.00	190	00	30-40	2.75
34	DCEP(RP)	350	30.00	190	00	30-40	2.75
35	DCEP(RP)	350	30.00	190	00	30-40	2.75
36	DCEP(RP)	350	30.00	190	00	30-40	2.75
37	DCEP(RP)	580	27.00	330	00	30-40	3.75
38	DCEP(RP)	580	27.00	330	00	30-40	3.75
39	DCEP(RP)	580	27.00	330	00	30-40	3.75
40	DCEP(RP)	580	27.00	330	00	30-40	3.75
41	DCEP(RP)	580	27.00	330	00	30-40	3.75
42	DCEN(SP)	235	20.00	105	00	30-40	1.00
43	DCEN(SP)	235	20.00	105	00	30-40	1.00
44	DCEN(SP)	235	20.00	105	00	30-40	1.00
45	DCEN(SP)	235	20.00	105	00	30-40	1.00
46	DCEN(SP)	235	20.00	105	00	30-40	1.00
47	DCEN(SP)	335	21.00	110	00	30-40	1.00
48	DCEN(SP)	335	21.00	110	00	30-40	1.00
49	DCEN(SP)	335	21.00	110	00	30-40	1.00
50	DCEN(SP)	335	21.00	110	00	30-40	1.00
51	DCEN(SP)	335	21.00	110	00	30-40	1.00
52	DCEP(RP)	325	29.00	150	00	30-40	1.00
53	DCEP(RP)	325	29.00	150	00	30-40	1.00
54	DCEP(RP)	325	29.00	150	00	30-40	1.00
55	DCEP(RP)	325	29.00	150	00	30-40	1.00
56	DCEP(RP)	325	29.00	150	00	30-40	1.00
57	DCEP(RP)	450	29.00	175	00	30-40	2.75
58	DCEP(RP)	450	29.00	175	00	30-40	2.75
59	DCEP(RP)	450	29.00	175	00	30-40	2.75
60	DCEP(RP)	450	29.00	175	00	30-40	2.75
61	DCEP(RP)	450	29.00	175	00	30-40	2.75
62	DCEN(SP)	130	18.00	80	00	30-40	1.00
63	DCEN(SP)	130	18.00	80	00	30-40	1.00
64	DCEN(SP)	130	18.00	80	00	30-40	1.00
65	DCEN(SP)	130	18.00	80	00	30-40	1.00
66	DCEN(SP)	130	18.00	80	00	30-40	1.00

67	DCEN(SP)	185	20.00	108 00	30-40	1.00
68	DCEN(SP)	185	20.00	108 00	30-40	1.00
69	DCEN(SP)	185	20.00	108 00	30-40	1.00
70	DCEN(SP)	185	20.00	108 00	30-40	1.00
71	DCEN(SP)	185	20.00	108 00	30-40	1.00
72	DCEN(SP)	190	21.00	110 00	30-40	1.00
73	DCEN(SP)	190	21.00	110 00	30-40	1.00
74	DCEN(SP)	190	21.00	110 00	30-40	1.00
75	DCEN(SP)	190	21.00	110 00	30-40	1.00
76	DCEN(SP)	190	21.00	110 00	30-40	1.00
77	DCEN(SP)	150	18.00	100 00	30-40	1.00
78	DCEN(SP)	150	18.00	100 00	30-40	1.00
79	DCEN(SP)	150	18.00	100 00	30-40	1.00
80	DCEN(SP)	150	18.00	100 00	30-40	1.00
81	DCEN(SP)	150	18.00	100 00	30-40	1.00
82	DCEN(SP)	180	19.00	115 00	30-40	1.00
83	DCEN(SP)	180	19.00	115 00	30-40	1.00
84	DCEN(SP)	180	19.00	115 00	30-40	1.00
85	DCEN(SP)	180	19.00	115 00	30-40	1.00
86	DCEN(SP)	180	19.00	115 00	30-40	1.00
87	DCEN(SP)	150	18.00	90 00	30-40	1.00
88	DCEN(SP)	150	18.00	90 00	30-40	1.00
89	DCEN(SP)	150	18.00	90 00	30-40	1.00
90	DCEN(SP)	150	18.00	90 00	30-40	1.00
91	DCEN(SP)	150	18.00	90 00	30-40	1.00
92	DCEN(SP)	170	19.00	105 00	30-40	1.00
93	DCEN(SP)	170	19.00	105 00	30-40	1.00
94	DCEN(SP)	170	19.00	105 00	30-40	1.00
95	DCEN(SP)	170	19.00	105 00	30-40	1.00
96	DCEN(SP)	170	19.00	105 00	30-40	1.00
97	DCEP(RP)	300	27.50	170 00	30-40	1.00
98	DCEP(RP)	300	27.50	170 00	30-40	1.00
99	DCEP(RP)	185	24.00	265 00	30-40	0.50
100	DCEP(RP)	300	27.00	170 00	30-40	1.00

FCAHGRPA.DBF (Welding parameters for groove joint of FCAH)

Fields name → / Records ↓	Material (Notation)	Working thickness (WT_inch)	Joint type (Joint_prep)	Welding position (Weld_posi)	Type of process (Proc_type)
1	LCS	0.1250	SQUARE GROOVE	FLAT(1G)	GAS SHIELDED TYPE
2	LCS	0.1875	SQUARE GROOVE	FLAT(1G)	GAS SHIELDED TYPE
3	LCS	0.2500	SQUARE GROOVE	FLAT(1G)	GAS SHIELDED TYPE
4	MCS	0.2500	SQUARE GROOVE	FLAT(1G)	GAS SHIELDED TYPE
5	HCS	0.2500	SQUARE GROOVE	FLAT(1G)	GAS SHIELDED TYPE
6	TS	0.2500	SQUARE GROOVE	FLAT(1G)	GAS SHIELDED TYPE
7	AS	0.2500	SQUARE GROOVE	FLAT(1G)	GAS SHIELDED TYPE
8	LCS	0.3750	SINGLE V GROOVE _60	FLAT(1G)	GAS SHIELDED TYPE
9	LCS	0.5000	SQUARE GROOVE	FLAT(1G)	GAS SHIELDED TYPE
10	LCS	0.5000	SINGLE V GROOVE _60	FLAT(1G)	GAS SHIELDED TYPE
11	MCS	0.5000	SINGLE V GROOVE _60	FLAT(1G)	GAS SHIELDED TYPE
12	HCS	0.5000	SINGLE V GROOVE _60	FLAT(1G)	GAS SHIELDED TYPE
13	TS	0.5000	SINGLE V GROOVE _60	FLAT(1G)	GAS SHIELDED TYPE
14	AS	0.5000	SINGLE V GROOVE _60	FLAT(1G)	GAS SHIELDED TYPE
15	LCS	0.6250	SINGLE V GROOVE _60	FLAT(1G)	GAS SHIELDED TYPE
16	MCS	0.6250	SINGLE V GROOVE _60	FLAT(1G)	GAS SHIELDED TYPE
17	HCS	0.6250	SINGLE V GROOVE _60	FLAT(1G)	GAS SHIELDED TYPE
18	TS	0.6250	SINGLE V GROOVE _60	FLAT(1G)	GAS SHIELDED TYPE
19	AS	0.6250	SINGLE V GROOVE _60	FLAT(1G)	GAS SHIELDED TYPE
20	LCS	0.6250	SINGLE V GROOVE _30	FLAT(1G)	GAS SHIELDED TYPE
21	MCS	0.6250	SINGLE V GROOVE _30	FLAT(1G)	GAS SHIELDED TYPE
22	HCS	0.6250	SINGLE V GROOVE _30	FLAT(1G)	GAS SHIELDED TYPE
23	TS	0.6250	SINGLE V GROOVE _30	FLAT(1G)	GAS SHIELDED TYPE
24	AS	0.6250	SINGLE V GROOVE _30	FLAT(1G)	GAS SHIELDED TYPE
25	LCS	0.7500	SINGLE V GROOVE _60	FLAT(1G)	GAS SHIELDED TYPE
26	MCS	0.7500	SINGLE V GROOVE _60	FLAT(1G)	GAS SHIELDED TYPE
27	HCS	0.7500	SINGLE V GROOVE _60	FLAT(1G)	GAS SHIELDED TYPE
28	TS	0.7500	SINGLE V GROOVE _60	FLAT(1G)	GAS SHIELDED TYPE
29	AS	0.7500	SINGLE V GROOVE _60	FLAT(1G)	GAS SHIELDED TYPE
30	LCS	0.7500	SINGLE V GROOVE _30	FLAT(1G)	GAS SHIELDED TYPE
31	MCS	0.7500	SINGLE V GROOVE _30	FLAT(1G)	GAS SHIELDED TYPE
32	HCS	0.7500	SINGLE V GROOVE _30	FLAT(1G)	GAS SHIELDED TYPE
33	TS	0.7500	SINGLE V GROOVE _30	FLAT(1G)	GAS SHIELDED TYPE
34	AS	0.7500	SINGLE V GROOVE _30	FLAT(1G)	GAS SHIELDED TYPE
35	LCS	0.7500	SINGLE V GROOVE _40	FLAT(1G)	GAS SHIELDED TYPE
36	MCS	0.7500	SINGLE V GROOVE _40	FLAT(1G)	GAS SHIELDED TYPE
37	HCS	0.7500	SINGLE V GROOVE _40	FLAT(1G)	GAS SHIELDED TYPE
38	TS	0.7500	SINGLE V GROOVE _40	FLAT(1G)	GAS SHIELDED TYPE
39	AS	0.7500	SINGLE V GROOVE _40	FLAT(1G)	GAS SHIELDED TYPE
40	LCS	1.0000	SINGLE V GROOVE _60	FLAT(1G)	GAS SHIELDED TYPE
41	MCS	1.0000	SINGLE V GROOVE _60	FLAT(1G)	GAS SHIELDED TYPE
42	HCS	1.0000	SINGLE V GROOVE _60	FLAT(1G)	GAS SHIELDED TYPE
43	TS	1.0000	SINGLE V GROOVE _60	FLAT(1G)	GAS SHIELDED TYPE
44	AS	1.0000	SINGLE V GROOVE _60	FLAT(1G)	GAS SHIELDED TYPE
45	LCS	1.0000	SINGLE V GROOVE _30	FLAT(1G)	GAS SHIELDED TYPE
46	MCS	1.0000	SINGLE V GROOVE _30	FLAT(1G)	GAS SHIELDED TYPE
47	HCS	1.0000	SINGLE V GROOVE _30	FLAT(1G)	GAS SHIELDED TYPE
48	TS	1.0000	SINGLE V GROOVE _30	FLAT(1G)	GAS SHIELDED TYPE
49	AS	1.0000	SINGLE V GROOVE _30	FLAT(1G)	GAS SHIELDED TYPE
50	LCS	1.0000	SINGLE V GROOVE _40	FLAT(1G)	GAS SHIELDED TYPE
51	MCS	1.0000	SINGLE V GROOVE _40	FLAT(1G)	GAS SHIELDED TYPE
52	HCS	1.0000	SINGLE V GROOVE _40	FLAT(1G)	GAS SHIELDED TYPE
53	TS	1.0000	SINGLE V GROOVE _40	FLAT(1G)	GAS SHIELDED TYPE
54	AS	1.0000	SINGLE V GROOVE _40	FLAT(1G)	GAS SHIELDED TYPE
55	LCS	1.0000	DOUBLE V GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE
56	MCS	1.0000	DOUBLE V GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE
57	HCS	1.0000	DOUBLE V GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE
58	TS	1.0000	DOUBLE V GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE
59	AS	1.0000	DOUBLE V GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE
60	LCS	1.0000	DOUBLE BEVEL GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE
61	MCS	1.0000	DOUBLE BEVEL GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE
62	HCS	1.0000	DOUBLE BEVEL GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE
63	AS	1.0000	DOUBLE BEVEL GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE
64	TS	1.0000	DOUBLE BEVEL GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE
65	LCS	1.0000	SINGLE BEVEL GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE
66	MCS	1.0000	SINGLE BEVEL GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE

67	HCS	1.0000	SINGLE BEVEL GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE
68	TS	1.0000	SINGLE BEVEL GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE
69	AS	1.0000	SINGLE BEVEL GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE
70	LCS	2.0000	DOUBLE BEVEL GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE
71	MCS	2.0000	DOUBLE BEVEL GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE
72	HCS	2.0000	DOUBLE BEVEL GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE
73	TS	2.0000	DOUBLE BEVEL GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE
74	AS	2.0000	DOUBLE BEVEL GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE
75	LCS	2.0000	DOUBLE V GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE
76	MCS	2.0000	DOUBLE V GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE
77	HCS	2.0000	DOUBLE V GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE
78	TS	2.0000	DOUBLE V GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE
79	AS	2.0000	DOUBLE V GROOVE _45	FLAT(1G)	GAS SHIELDED TYPE
80	LCS	0.5000	SINGLE BEVEL GROOVE _45	HORIZONTAL(2G)	GAS SHIELDED TYPE
81	MCS	0.5000	SINGLE BEVEL GROOVE _45	HORIZONTAL(2G)	GAS SHIELDED TYPE
82	HCS	0.5000	SINGLE BEVEL GROOVE _45	HORIZONTAL(2G)	GAS SHIELDED TYPE
83	TS	0.5000	SINGLE BEVEL GROOVE _45	HORIZONTAL(2G)	GAS SHIELDED TYPE
84	AS	0.5000	SINGLE BEVEL GROOVE _45	HORIZONTAL(2G)	GAS SHIELDED TYPE
85	LCS	1.0000	SINGLE BEVEL GROOVE _45	HORIZONTAL(2G)	GAS SHIELDED TYPE
86	MCS	1.0000	SINGLE BEVEL GROOVE _45	HORIZONTAL(2G)	GAS SHIELDED TYPE
87	HCS	1.0000	SINGLE BEVEL GROOVE _45	HORIZONTAL(2G)	GAS SHIELDED TYPE
88	TS	1.0000	SINGLE BEVEL GROOVE _45	HORIZONTAL(2G)	GAS SHIELDED TYPE
89	AS	1.0000	SINGLE BEVEL GROOVE _45	HORIZONTAL(2G)	GAS SHIELDED TYPE
90	LCS	0.3750	SINGLE V GROOVE _60	VERTICAL(3G)	GAS SHIELDED TYPE
91	MCS	0.3750	SINGLE V GROOVE _60	VERTICAL(3G)	GAS SHIELDED TYPE
92	HCS	0.3750	SINGLE V GROOVE _60	VERTICAL(3G)	GAS SHIELDED TYPE
93	TS	0.3750	SINGLE V GROOVE _60	VERTICAL(3G)	GAS SHIELDED TYPE
94	AS	0.3750	SINGLE V GROOVE _60	VERTICAL(3G)	GAS SHIELDED TYPE
95	LCS	0.5000	SINGLE V GROOVE _60	VERTICAL(3G)	GAS SHIELDED TYPE
96	MCS	0.5000	SINGLE V GROOVE _60	VERTICAL(3G)	GAS SHIELDED TYPE
97	HCS	0.5000	SINGLE V GROOVE _60	VERTICAL(3G)	GAS SHIELDED TYPE
98	TS	0.5000	SINGLE V GROOVE _60	VERTICAL(3G)	GAS SHIELDED TYPE
99	LCS	0.1400	SQUARE GROOVE	FLAT(1G)	SELF SHIELDED TYPE
100	MCS	0.1400	SQUARE GROOVE	FLAT(1G)	SELF SHIELDED TYPE
101	HCS	0.1400	SQUARE GROOVE	FLAT(1G)	SELF SHIELDED TYPE
102	TS	0.1400	SQUARE GROOVE	FLAT(1G)	SELF SHIELDED TYPE
103	AS	0.1400	SQUARE GROOVE	FLAT(1G)	SELF SHIELDED TYPE
104	LCS	0.3750	SQUARE GROOVE	FLAT(1G)	SELF SHIELDED TYPE
105	MCS	0.3750	SQUARE GROOVE	FLAT(1G)	SELF SHIELDED TYPE
106	HCS	0.3750	SQUARE GROOVE	FLAT(1G)	SELF SHIELDED TYPE
107	TS	0.3750	SQUARE GROOVE	FLAT(1G)	SELF SHIELDED TYPE
108	AS	0.3750	SQUARE GROOVE	FLAT(1G)	SELF SHIELDED TYPE
109	LCS	0.5000	SINGLE V GROOVE _30	FLAT(1G)	SELF SHIELDED TYPE
110	MCS	0.5000	SINGLE V GROOVE _30	FLAT(1G)	SELF SHIELDED TYPE
111	HCS	0.5000	SINGLE V GROOVE _30	FLAT(1G)	SELF SHIELDED TYPE
112	TS	0.5000	SINGLE V GROOVE _30	FLAT(1G)	SELF SHIELDED TYPE
113	AS	0.5000	SINGLE V GROOVE _30	FLAT(1G)	SELF SHIELDED TYPE
114	LCS	1.0000	SINGLE V GROOVE _30	FLAT(1G)	SELF SHIELDED TYPE
115	MCS	1.0000	SINGLE V GROOVE _30	FLAT(1G)	SELF SHIELDED TYPE
116	HCS	1.0000	SINGLE V GROOVE _30	FLAT(1G)	SELF SHIELDED TYPE
117	TS	1.0000	SINGLE V GROOVE _30	FLAT(1G)	SELF SHIELDED TYPE
118	LCS	0.3750	SINGLE BEVEL GROOVE _20	FLAT(1G)	SELF SHIELDED TYPE
119	MCS	0.3750	SINGLE BEVEL GROOVE _20	FLAT(1G)	SELF SHIELDED TYPE
120	HCS	0.3750	SINGLE BEVEL GROOVE _20	FLAT(1G)	SELF SHIELDED TYPE
121	TS	0.3750	SINGLE BEVEL GROOVE _20	FLAT(1G)	SELF SHIELDED TYPE
122	AS	0.3750	SINGLE BEVEL GROOVE _20	FLAT(1G)	SELF SHIELDED TYPE
123	LCS	0.5000	DOUBLE V GROOVE _60	FLAT(1G)	SELF SHIELDED TYPE
124	MCS	0.5000	DOUBLE V GROOVE _60	FLAT(1G)	SELF SHIELDED TYPE
125	HCS	0.5000	DOUBLE V GROOVE _60	FLAT(1G)	SELF SHIELDED TYPE
126	TS	0.5000	DOUBLE V GROOVE _60	FLAT(1G)	SELF SHIELDED TYPE
127	AS	0.5000	DOUBLE V GROOVE _60	FLAT(1G)	SELF SHIELDED TYPE
128	LCS	1.2500	SINGLE BEVEL GROOVE _20	FLAT(1G)	SELF SHIELDED TYPE
129	MCS	1.2500	SINGLE BEVEL GROOVE _20	FLAT(1G)	SELF SHIELDED TYPE
130	HCS	1.2500	SINGLE BEVEL GROOVE _20	FLAT(1G)	SELF SHIELDED TYPE
131	TS	1.2500	SINGLE BEVEL GROOVE _20	FLAT(1G)	SELF SHIELDED TYPE
132	AS	1.2500	SINGLE BEVEL GROOVE _20	FLAT(1G)	SELF SHIELDED TYPE

133	LCS	3.0000	DOUBLE V GROOVE _60	FLAT(1G)	SELF SHIELDED TYPE
134	MCS	3.0000	DOUBLE V GROOVE _60	FLAT(1G)	SELF SHIELDED TYPE
135	HCS	3.0000	DOUBLE V GROOVE _60	FLAT(1G)	SELF SHIELDED TYPE
136	TS	3.0000	DOUBLE V GROOVE _60	FLAT(1G)	SELF SHIELDED TYPE
137	AS	3.0000	DOUBLE V GROOVE _60	FLAT(1G)	SELF SHIELDED TYPE
138	LCS	0.3125	SINGLE BEVEL GROOVE _45	HORIZONTAL(2G)	SELF SHIELDED TYPE
139	MCS	0.3125	SINGLE BEVEL GROOVE _45	HORIZONTAL(2G)	SELF SHIELDED TYPE
140	HCS	0.3125	SINGLE BEVEL GROOVE _45	HORIZONTAL(2G)	SELF SHIELDED TYPE
141	TS	0.3125	SINGLE BEVEL GROOVE _45	HORIZONTAL(2G)	SELF SHIELDED TYPE
142	AS	0.3125	SINGLE BEVEL GROOVE _45	HORIZONTAL(2G)	SELF SHIELDED TYPE
143	LCS	0.7500	DOUBLE BEVEL GROOVE _45	HORIZONTAL(2G)	SELF SHIELDED TYPE
144	MCS	0.7500	DOUBLE BEVEL GROOVE _45	HORIZONTAL(2G)	SELF SHIELDED TYPE
145	HCS	0.7500	DOUBLE BEVEL GROOVE _45	HORIZONTAL(2G)	SELF SHIELDED TYPE
146	TS	0.7500	DOUBLE BEVEL GROOVE _45	HORIZONTAL(2G)	SELF SHIELDED TYPE
147	AS	0.7500	DOUBLE BEVEL GROOVE _45	HORIZONTAL(2G)	SELF SHIELDED TYPE
148	LCS	1.2500	SINGLE BEVEL GROOVE _45	HORIZONTAL(2G)	SELF SHIELDED TYPE
149	MCS	1.2500	SINGLE BEVEL GROOVE _45	HORIZONTAL(2G)	SELF SHIELDED TYPE
150	HCS	1.2500	SINGLE BEVEL GROOVE _45	HORIZONTAL(2G)	SELF SHIELDED TYPE
151	TS	1.2500	SINGLE BEVEL GROOVE _45	HORIZONTAL(2G)	SELF SHIELDED TYPE
152	AS	1.2500	SINGLE BEVEL GROOVE _45	HORIZONTAL(2G)	SELF SHIELDED TYPE
153	LCS	1.5000	DOUBLE BEVEL GROOVE _45	HORIZONTAL(2G)	SELF SHIELDED TYPE
154	MCS	1.5000	DOUBLE BEVEL GROOVE _45	HORIZONTAL(2G)	SELF SHIELDED TYPE
155	HCS	1.5000	DOUBLE BEVEL GROOVE _45	HORIZONTAL(2G)	SELF SHIELDED TYPE
156	TS	1.5000	DOUBLE BEVEL GROOVE _45	HORIZONTAL(2G)	SELF SHIELDED TYPE
157	AS	1.5000	DOUBLE BEVEL GROOVE _45	HORIZONTAL(2G)	SELF SHIELDED TYPE
158	LCS	0.1050	SQUARE GROOVE	VERTICAL(3G)	SELF SHIELDED TYPE
159	MCS	0.1050	SQUARE GROOVE	VERTICAL(3G)	SELF SHIELDED TYPE
160	HCS	0.1050	SQUARE GROOVE	VERTICAL(3G)	SELF SHIELDED TYPE
161	TS	0.1050	SQUARE GROOVE	VERTICAL(3G)	SELF SHIELDED TYPE
162	AS	0.1050	SQUARE GROOVE	VERTICAL(3G)	SELF SHIELDED TYPE
163	LCS	0.2500	SQUARE GROOVE	VERTICAL(3G)	SELF SHIELDED TYPE
164	MCS	0.2500	SQUARE GROOVE	VERTICAL(3G)	SELF SHIELDED TYPE
165	HCS	0.2500	SQUARE GROOVE	VERTICAL(3G)	SELF SHIELDED TYPE
166	TS	0.2500	SQUARE GROOVE	VERTICAL(3G)	SELF SHIELDED TYPE
167	AS	0.2500	SQUARE GROOVE	VERTICAL(3G)	SELF SHIELDED TYPE
168	LCS	0.3125	SINGLE V GROOVE _60	VERTICAL(3G)	SELF SHIELDED TYPE
169	MCS	0.3125	SINGLE V GROOVE _60	VERTICAL(3G)	SELF SHIELDED TYPE
170	HCS	0.3125	SINGLE V GROOVE _60	VERTICAL(3G)	SELF SHIELDED TYPE
171	TS	0.3125	SINGLE V GROOVE _60	VERTICAL(3G)	SELF SHIELDED TYPE
172	AS	0.3125	SINGLE V GROOVE _60	VERTICAL(3G)	SELF SHIELDED TYPE
173	LCS	0.3750	SINGLE V GROOVE _45	VERTICAL(3G)	SELF SHIELDED TYPE
174	MCS	0.3750	SINGLE V GROOVE _45	VERTICAL(3G)	SELF SHIELDED TYPE
175	HCS	0.3750	SINGLE V GROOVE _45	VERTICAL(3G)	SELF SHIELDED TYPE
176	TS	0.3750	SINGLE V GROOVE _45	VERTICAL(3G)	SELF SHIELDED TYPE
177	AS	0.3750	SINGLE V GROOVE _45	VERTICAL(3G)	SELF SHIELDED TYPE
178	LCS	0.3750	SINGLE BEVEL GROOVE _45	VERTICAL(3G)	SELF SHIELDED TYPE
179	MCS	0.3750	SINGLE BEVEL GROOVE _45	VERTICAL(3G)	SELF SHIELDED TYPE
180	HCS	0.3750	SINGLE BEVEL GROOVE _45	VERTICAL(3G)	SELF SHIELDED TYPE
181	TS	0.3750	SINGLE BEVEL GROOVE _45	VERTICAL(3G)	SELF SHIELDED TYPE
182	AS	0.3750	SINGLE BEVEL GROOVE _45	VERTICAL(3G)	SELF SHIELDED TYPE
183	LCS	1.0000	SINGLE V GROOVE _60	VERTICAL(3G)	SELF SHIELDED TYPE
184	MCS	1.0000	SINGLE V GROOVE _60	VERTICAL(3G)	SELF SHIELDED TYPE
185	HCS	1.0000	SINGLE V GROOVE _60	VERTICAL(3G)	SELF SHIELDED TYPE
186	TS	1.0000	SINGLE V GROOVE _60	VERTICAL(3G)	SELF SHIELDED TYPE
187	AS	1.0000	SINGLE V GROOVE _60	VERTICAL(3G)	SELF SHIELDED TYPE
188	LCS	1.0000	SINGLE V GROOVE _45	VERTICAL(3G)	SELF SHIELDED TYPE
189	MCS	1.0000	SINGLE V GROOVE _45	VERTICAL(3G)	SELF SHIELDED TYPE
190	HCS	1.0000	SINGLE V GROOVE _45	VERTICAL(3G)	SELF SHIELDED TYPE
191	TS	1.0000	SINGLE V GROOVE _45	VERTICAL(3G)	SELF SHIELDED TYPE
192	AS	1.0000	SINGLE V GROOVE _45	VERTICAL(3G)	SELF SHIELDED TYPE
193	LCS	1.5000	SINGLE BEVEL GROOVE _45	VERTICAL(3G)	SELF SHIELDED TYPE
194	MCS	1.5000	SINGLE BEVEL GROOVE _45	VERTICAL(3G)	SELF SHIELDED TYPE
195	HCS	1.5000	SINGLE BEVEL GROOVE _45	VERTICAL(3G)	SELF SHIELDED TYPE
196	TS	1.5000	SINGLE BEVEL GROOVE _45	VERTICAL(3G)	SELF SHIELDED TYPE
197	AS	1.5000	SINGLE BEVEL GROOVE _45	VERTICAL(3G)	SELF SHIELDED TYPE
198	LCS	0.1050	SQUARE GROOVE	OVERHEAD(4G)	SELF SHIELDED TYPE
199	MCS	0.1050	SQUARE GROOVE	OVERHEAD(4G)	SELF SHIELDED TYPE

200	HCS	0.1050	SQUARE GROOVE	OVERHEAD(4G)	SELF SHIELDED TYPE
201	TS	0.1050	SQUARE GROOVE	OVERHEAD(4G)	SELF SHIELDED TYPE
202	AS	0.1050	SQUARE GROOVE	OVERHEAD(4G)	SELF SHIELDED TYPE
203	LCS	0.3125	SINGLE V GROOVE _45	OVERHEAD(4G)	SELF SHIELDED TYPE
204	MCS	0.3125	SINGLE V GROOVE _45	OVERHEAD(4G)	SELF SHIELDED TYPE
205	HCS	0.3125	SINGLE V GROOVE _45	OVERHEAD(4G)	SELF SHIELDED TYPE
206	TS	0.3125	SINGLE V GROOVE _45	OVERHEAD(4G)	SELF SHIELDED TYPE
207	AS	0.3125	SINGLE V GROOVE _45	OVERHEAD(4G)	SELF SHIELDED TYPE
208	LCS	0.7500	SINGLE V GROOVE _45	OVERHEAD(4G)	SELF SHIELDED TYPE
209	MCS	0.7500	SINGLE V GROOVE _45	OVERHEAD(4G)	SELF SHIELDED TYPE
210	HCS	0.7500	SINGLE V GROOVE _45	OVERHEAD(4G)	SELF SHIELDED TYPE
211	TS	0.7500	SINGLE V GROOVE _45	OVERHEAD(4G)	SELF SHIELDED TYPE
212	AS	0.7500	SINGLE V GROOVE _45	OVERHEAD(4G)	SELF SHIELDED TYPE
213	LCS	1.0000	SINGLE V GROOVE _45	OVERHEAD(4G)	SELF SHIELDED TYPE
214	MCS	1.0000	SINGLE V GROOVE _45	OVERHEAD(4G)	SELF SHIELDED TYPE
215	HCS	1.0000	SINGLE V GROOVE _45	OVERHEAD(4G)	SELF SHIELDED TYPE
216	TS	1.0000	SINGLE V GROOVE _45	OVERHEAD(4G)	SELF SHIELDED TYPE
217	AS	1.0000	SINGLE V GROOVE _45	OVERHEAD(4G)	SELF SHIELDED TYPE
218	SS	0.2500	SINGLE V GROOVE _45	FLAT(1G)	SELF SHIELDED TYPE
219	SS	0.3750	SINGLE V GROOVE _45	FLAT(1G)	SELF SHIELDED TYPE
220	SS	0.5000	SINGLE V GROOVE _30	FLAT(1G)	SELF SHIELDED TYPE
221	SS	0.5000	DOUBLE V GROOVE _45	FLAT(1G)	SELF SHIELDED TYPE
222	SS	0.7500	SINGLE V GROOVE _30	FLAT(1G)	SELF SHIELDED TYPE
223	SS	0.8750	SINGLE V GROOVE _20	FLAT(1G)	SELF SHIELDED TYPE
224	SS	1.2500	SINGLE V GROOVE _20	FLAT(1G)	SELF SHIELDED TYPE
225	SS	3.0000	DOUBLE V GROOVE _45	FLAT(1G)	SELF SHIELDED TYPE

FCAWGRPA.DBF (Welding parameters for groove joint of FCAW) PART II

name → / s ↓	Number of Passes (No_passes)	Dia_of Filler (Dia_fm)	Polarity (Polarit)	Current (Curr_amps)	Voltage (Voltage)	Filler matl feedrate (Fm_furate)	Travel speed (Tr_speed)	Gas flow (Gas_flrate)	Filler Extension (Ext_fm)
1	1	0.09375	DCEP(RP)	325	25.00	300	56	35	0.00
2	1	0.09375	DCEP(RP)	350	25.00	300	48	35	0.00
3	1	0.07813	DCEP(RP)	425	30.00	275	45	30-40	0.00
4	1	0.07813	DCEP(RP)	425	30.00	275	45	30-40	0.00
5	1	0.07813	DCEP(RP)	425	30.00	275	45	30-40	0.00
6	1	0.07813	DCEP(RP)	425	30.00	275	45	30-40	0.00
7	1	0.07813	DCEP(RP)	425	30.00	275	45	30-40	0.00
8	1	0.12500	DCEP(RP)	500	26.00	250	24	30-40	0.00
9	2	0.09375	DCEP(RP)	450	32.00	195	22	30-40	0.00
10	2	0.09375	DCEP(RP)	480	30.00	225	20	30-40	0.00
11	2	0.09375	DCEP(RP)	480	30.00	225	20	30-40	0.00
12	2	0.09375	DCEP(RP)	480	30.00	225	20	30-40	0.00
13	2	0.09375	DCEP(RP)	480	30.00	225	20	30-40	0.00
14	2	0.09375	DCEP(RP)	480	30.00	225	20	30-40	0.00
15	2	0.12500	DCEP(RP)	550	29.50	225	18	30-40	0.00
16	2	0.12500	DCEP(RP)	550	29.50	225	18	30-40	0.00
17	2	0.12500	DCEP(RP)	550	29.50	225	18	30-40	0.00
18	2	0.12500	DCEP(RP)	550	29.50	225	18	30-40	0.00
19	2	0.12500	DCEP(RP)	550	29.50	225	18	30-40	0.00
20	3	0.09375	DCEP(RP)	480	32.00	225	15	30-40	0.00
21	3	0.09375	DCEP(RP)	480	32.00	225	15	30-40	0.00
22	3	0.09375	DCEP(RP)	480	32.00	225	15	30-40	0.00
23	3	0.09375	DCEP(RP)	480	32.00	225	15	30-40	0.00
24	3	0.09375	DCEP(RP)	480	32.00	225	15	30-40	0.00
25	3	0.12500	DCEP(RP)	550	28.00	225	18	30-40	0.00
26	3	0.12500	DCEP(RP)	550	28.00	225	18	30-40	0.00
27	3	0.12500	DCEP(RP)	550	28.00	225	18	30-40	0.00
28	3	0.12500	DCEP(RP)	550	28.00	225	18	30-40	0.00
29	3	0.12500	DCEP(RP)	550	28.00	225	18	30-40	0.00
30	6	0.12500	DCEP(RP)	600	32.50	225	18	30-40	0.00
31	6	0.12500	DCEP(RP)	600	32.50	225	18	30-40	0.00
32	6	0.12500	DCEP(RP)	600	32.50	225	18	30-40	0.00

33	6	0.12500	DCEP(RP)	600	32.50	225	18	30-40	0.00
34	6	0.12500	DCEP(RP)	600	32.50	225	18	30-40	0.00
35	6	0.12500	DCEP(RP)	580	31.50	225	17	30-40	0.00
36	6	0.12500	DCEP(RP)	580	31.50	225	17	30-40	0.00
37	6	0.12500	DCEP(RP)	580	31.50	225	17	30-40	0.00
38	6	0.12500	DCEP(RP)	580	31.50	225	17	30-40	0.00
39	6	0.12500	DCEP(RP)	580	31.50	225	17	30-40	0.00
40	6	0.09375	DCEP(RP)	480	32.00	225	17	30-40	0.00
41	6	0.09375	DCEP(RP)	480	32.00	225	17	30-40	0.00
42	6	0.09375	DCEP(RP)	480	32.00	225	17	30-40	0.00
43	6	0.09375	DCEP(RP)	480	32.00	225	17	30-40	0.00
44	6	0.09375	DCEP(RP)	480	32.00	225	17	30-40	0.00
45	10	0.12500	DCEP(RP)	575	32.00	225	15	30-40	0.00
46	10	0.12500	DCEP(RP)	575	32.00	225	15	30-40	0.00
47	10	0.12500	DCEP(RP)	575	32.00	225	15	30-40	0.00
48	10	0.12500	DCEP(RP)	575	32.00	225	15	30-40	0.00
49	10	0.12500	DCEP(RP)	575	32.00	225	15	30-40	0.00
50	10	0.12500	DCEP(RP)	575	31.50	200	14	30-40	0.00
51	10	0.12500	DCEP(RP)	575	31.50	200	14	30-40	0.00
52	10	0.12500	DCEP(RP)	575	31.50	200	14	30-40	0.00
53	10	0.12500	DCEP(RP)	575	31.50	200	14	30-40	0.00
54	10	0.12500	DCEP(RP)	575	31.50	200	14	30-40	0.00
55	6	0.09375	DCEP(RP)	450	32.00	195	14	30-40	0.00
56	6	0.09375	DCEP(RP)	450	32.00	195	14	30-40	0.00
57	6	0.09375	DCEP(RP)	450	32.00	195	14	30-40	0.00
58	6	0.09375	DCEP(RP)	450	32.00	195	14	30-40	0.00
59	6	0.09375	DCEP(RP)	450	32.00	195	14	30-40	0.00
60	4	0.09375	DCEP(RP)	450	32.00	195	12	30-40	0.00
61	4	0.09375	DCEP(RP)	450	32.00	195	12	30-40	0.00
62	4	0.09375	DCEP(RP)	450	32.00	195	12	30-40	0.00
63	4	0.09375	DCEP(RP)	450	32.00	195	12	30-40	0.00
64	4	0.09375	DCEP(RP)	450	32.00	195	12	30-40	0.00
65	8	0.12500	DCEP(RP)	600	32.00	195	17	30-40	0.00
66	8	0.12500	DCEP(RP)	600	32.00	195	17	30-40	0.00
67	8	0.12500	DCEP(RP)	600	32.00	195	17	30-40	0.00
68	8	0.12500	DCEP(RP)	600	32.00	195	17	30-40	0.00
69	8	0.12500	DCEP(RP)	600	32.00	195	17	30-40	0.00
70	10	0.09375	DCEP(RP)	450	32.00	195	17	30-40	0.00
71	10	0.09375	DCEP(RP)	450	32.00	195	17	30-40	0.00
72	10	0.09375	DCEP(RP)	450	32.00	195	17	30-40	0.00
73	10	0.09375	DCEP(RP)	450	32.00	195	17	30-40	0.00
74	10	0.09375	DCEP(RP)	450	32.00	195	17	30-40	0.00
75	14	0.09375	DCEP(RP)	450	32.00	195	17	30-40	0.00
76	14	0.09375	DCEP(RP)	450	32.00	195	17	30-40	0.00
77	14	0.09375	DCEP(RP)	450	32.00	195	17	30-40	0.00
78	14	0.09375	DCEP(RP)	450	32.00	195	17	30-40	0.00
79	14	0.09375	DCEP(RP)	450	32.00	195	17	30-40	0.00
80	6	0.07813	DCEP(RP)	350	28.00	175	16	30-40	0.00
81	6	0.07813	DCEP(RP)	350	28.00	175	16	30-40	0.00
82	6	0.07813	DCEP(RP)	350	28.00	175	16	30-40	0.00
83	6	0.07813	DCEP(RP)	350	28.00	175	16	30-40	0.00
84	6	0.07813	DCEP(RP)	350	28.00	175	16	30-40	0.00
85	18	0.07813	DCEP(RP)	350	28.00	175	16	30-40	0.00
86	18	0.07813	DCEP(RP)	350	28.00	175	16	30-40	0.00
87	18	0.07813	DCEP(RP)	350	28.00	175	16	30-40	0.00
88	18	0.07813	DCEP(RP)	350	28.00	175	16	30-40	0.00
89	18	0.07813	DCEP(RP)	350	28.00	175	16	30-40	0.00
90	2	0.06250	DCEP(RP)	220	23.00	165	10	30-40	0.00
91	2	0.06250	DCEP(RP)	220	23.00	165	10	30-40	0.00
92	2	0.06250	DCEP(RP)	220	23.00	165	10	30-40	0.00
93	2	0.06250	DCEP(RP)	220	23.00	165	10	30-40	0.00
94	2	0.06250	DCEP(RP)	220	23.00	165	10	30-40	0.00
95	3	0.06250	DCEP(RP)	220	23.00	165	10	30-40	0.00
96	3	0.06250	DCEP(RP)	220	23.00	165	10	30-40	0.00
97	3	0.06250	DCEP(RP)	220	23.00	165	10	30-40	0.00
98	3	0.06250	DCEP(RP)	220	23.00	165	10	30-40	0.00
99	1	0.09375	DCEP(RP)	300	29.00	150	00	NO NEED	2.75
100	1	0.09375	DCEP(RP)	300	29.00	150	00	NO NEED	2.75

101	1	0.09375	DCEP(RP)	300	29.00	150	00	NO NEED 2.75
102	1	0.09375	DCEP(RP)	300	29.00	150	00	NO NEED 2.75
103	1	0.09375	DCEP(RP)	300	29.00	150	00	NO NEED 2.75
104	2	0.12500	DCEP(RP)	500	33.00	200	00	NO NEED 2.75
105	2	0.12500	DCEP(RP)	500	33.00	200	00	NO NEED 2.75
106	2	0.12500	DCEP(RP)	500	33.00	200	00	NO NEED 2.75
107	2	0.12500	DCEP(RP)	500	33.00	200	00	NO NEED 2.75
108	2	0.12500	DCEP(RP)	500	33.00	200	00	NO NEED 2.75
109	3	0.12500	DCEP(RP)	500	32.00	200	00	NO NEED 2.75
110	3	0.12500	DCEP(RP)	500	32.00	200	00	NO NEED 2.75
111	3	0.12500	DCEP(RP)	500	32.00	200	00	NO NEED 2.75
112	3	0.12500	DCEP(RP)	500	32.00	200	00	NO NEED 2.75
113	3	0.12500	DCEP(RP)	500	32.00	200	00	NO NEED 2.75
114	6	0.12500	DCEP(RP)	550	36.00	300	00	NO NEED 3.75
115	6	0.12500	DCEP(RP)	550	36.00	300	00	NO NEED 3.75
116	6	0.12500	DCEP(RP)	550	36.00	300	00	NO NEED 3.75
117	6	0.12500	DCEP(RP)	550	36.00	300	00	NO NEED 3.75
118	2	0.12500	DCEP(RP)	500	32.00	200	00	NO NEED 2.75
119	2	0.12500	DCEP(RP)	500	32.00	200	00	NO NEED 2.75
120	2	0.12500	DCEP(RP)	500	32.00	200	00	NO NEED 2.75
121	2	0.12500	DCEP(RP)	500	32.00	200	00	NO NEED 2.75
122	2	0.12500	DCEP(RP)	500	32.00	200	00	NO NEED 2.75
123	2	0.09375	DCEP(RP)	350	29.00	190	00	NO NEED 2.75
124	2	0.09375	DCEP(RP)	350	29.00	190	00	NO NEED 2.75
125	2	0.09375	DCEP(RP)	350	29.00	190	00	NO NEED 2.75
126	2	0.09375	DCEP(RP)	350	29.00	190	00	NO NEED 2.75
127	2	0.09375	DCEP(RP)	350	29.00	190	00	NO NEED 2.75
128	7	0.12500	DCEP(RP)	550	36.00	300	00	NO NEED 3.75
129	7	0.12500	DCEP(RP)	550	36.00	300	00	NO NEED 3.75
130	7	0.12500	DCEP(RP)	550	36.00	300	00	NO NEED 3.75
131	7	0.12500	DCEP(RP)	550	36.00	300	00	NO NEED 3.75
132	7	0.12500	DCEP(RP)	550	36.00	300	00	NO NEED 3.75
133	26	0.12500	DCEP(RP)	550	36.00	300	00	NO NEED 3.75
134	26	0.12500	DCEP(RP)	550	36.00	300	00	NO NEED 3.75
135	26	0.12500	DCEP(RP)	550	36.00	300	00	NO NEED 3.75
136	26	0.12500	DCEP(RP)	550	36.00	300	00	NO NEED 3.75
137	26	0.12500	DCEP(RP)	550	36.00	300	00	NO NEED 3.75
138	3	0.09375	DCEP(RP)	300	28.00	150	00	NO NEED 2.75
139	3	0.09375	DCEP(RP)	300	28.00	150	00	NO NEED 2.75
140	3	0.09375	DCEP(RP)	300	28.00	150	00	NO NEED 2.75
141	3	0.09375	DCEP(RP)	300	28.00	150	00	NO NEED 2.75
142	3	0.09375	DCEP(RP)	300	28.00	150	00	NO NEED 2.75
143	6	0.09375	DCEP(RP)	300	28.00	140	00	NO NEED 2.75
144	6	0.09375	DCEP(RP)	300	28.00	140	00	NO NEED 2.75
145	6	0.09375	DCEP(RP)	300	28.00	140	00	NO NEED 2.75
146	6	0.09375	DCEP(RP)	300	28.00	140	00	NO NEED 2.75
147	6	0.09375	DCEP(RP)	300	28.00	140	00	NO NEED 2.75
148	16	0.12500	DCEP(RP)	400	29.00	160	00	NO NEED 2.75
149	16	0.12500	DCEP(RP)	400	29.00	160	00	NO NEED 2.75
150	16	0.12500	DCEP(RP)	400	29.00	160	00	NO NEED 2.75
151	16	0.12500	DCEP(RP)	400	29.00	160	00	NO NEED 2.75
152	16	0.12500	DCEP(RP)	400	29.00	160	00	NO NEED 2.75
153	12	0.12500	DCEP(RP)	400	29.00	160	00	NO NEED 2.75
154	12	0.12500	DCEP(RP)	400	29.00	160	00	NO NEED 2.75
155	12	0.12500	DCEP(RP)	400	29.00	160	00	NO NEED 2.75
156	12	0.12500	DCEP(RP)	400	29.00	160	00	NO NEED 2.75
157	12	0.12500	DCEP(RP)	400	29.00	160	00	NO NEED 2.75
158	1	0.07813	DCEN(SP)	250	20.00	110	00	NO NEED 1.00
159	1	0.07813	DCEN(SP)	250	20.00	110	00	NO NEED 1.00
160	1	0.07813	DCEN(SP)	250	20.00	110	00	NO NEED 1.00
161	1	0.07813	DCEN(SP)	250	20.00	110	00	NO NEED 1.00
162	1	0.07813	DCEN(SP)	250	20.00	110	00	NO NEED 1.00
163	3	0.07813	DCEN(SP)	350	25.00	230	00	NO NEED 1.00
164	3	0.07813	DCEN(SP)	350	25.00	230	00	NO NEED 1.00
165	3	0.07813	DCEN(SP)	350	25.00	230	00	NO NEED 1.00
166	3	0.07813	DCEN(SP)	350	25.00	230	00	NO NEED 1.00
167	3	0.07813	DCEN(SP)	350	25.00	230	00	NO NEED 1.00
168	1	0.06250	DCEN(SP)	150	18.00	90	00	NO NEED 1.00

169	1	0.06250	DCEN(SP)	150	18.00	90 00	NO NEED	1.00
170	1	0.06250	DCEN(SP)	150	18.00	90 00	NO NEED	1.00
171	1	0.06250	DCEN(SP)	150	18.00	90 00	NO NEED	1.00
172	1	0.06250	DCEN(SP)	150	18.00	90 00	NO NEED	1.00
173	2	0.06250	DCEN(SP)	170	19.00	105 00	NO NEED	1.00
174	2	0.06250	DCEN(SP)	170	19.00	105 00	NO NEED	1.00
175	2	0.06250	DCEN(SP)	170	19.00	105 00	NO NEED	1.00
176	2	0.06250	DCEN(SP)	170	19.00	105 00	NO NEED	1.00
177	2	0.06250	DCEN(SP)	170	19.00	105 00	NO NEED	1.00
178	1	0.06250	DCEN(SP)	170	19.00	105 00	NO NEED	1.00
179	1	0.06250	DCEN(SP)	170	19.00	105 00	NO NEED	1.00
180	1	0.06250	DCEN(SP)	170	19.00	105 00	NO NEED	1.00
181	1	0.06250	DCEN(SP)	170	19.00	105 00	NO NEED	1.00
182	1	0.06250	DCEN(SP)	170	19.00	105 00	NO NEED	1.00
183	1	0.06250	DCEN(SP)	195	21.00	120 00	NO NEED	1.00
184	1	0.06250	DCEN(SP)	195	21.00	120 00	NO NEED	1.00
185	1	0.06250	DCEN(SP)	195	21.00	120 00	NO NEED	1.00
186	1	0.06250	DCEN(SP)	195	21.00	120 00	NO NEED	1.00
187	1	0.06250	DCEN(SP)	195	21.00	120 00	NO NEED	1.00
188	6	0.07813	DCEN(SP)	190	19.00	110 00	NO NEED	1.00
189	6	0.07813	DCEN(SP)	190	19.00	110 00	NO NEED	1.00
190	6	0.07813	DCEN(SP)	190	19.00	110 00	NO NEED	1.00
191	6	0.07813	DCEN(SP)	190	19.00	110 00	NO NEED	1.00
192	6	0.07813	DCEN(SP)	190	19.00	110 00	NO NEED	1.00
193	4	0.07813	DCEN(SP)	190	19.00	110 00	NO NEED	1.00
194	4	0.07813	DCEN(SP)	190	19.00	110 00	NO NEED	1.00
195	4	0.07813	DCEN(SP)	190	19.00	110 00	NO NEED	1.00
196	4	0.07813	DCEN(SP)	190	19.00	110 00	NO NEED	1.00
197	4	0.07813	DCEN(SP)	190	19.00	110 00	NO NEED	1.00
198	1	0.06250	DCEN(SP)	150	18.00	100 00	NO NEED	1.00
199	1	0.06250	DCEN(SP)	150	18.00	100 00	NO NEED	1.00
200	1	0.06250	DCEN(SP)	150	18.00	100 00	NO NEED	1.00
201	1	0.06250	DCEN(SP)	150	18.00	100 00	NO NEED	1.00
202	1	0.06250	DCEN(SP)	150	18.00	100 00	NO NEED	1.00
203	2	0.06250	DCEN(SP)	150	18.00	90 00	NO NEED	1.00
204	2	0.06250	DCEN(SP)	150	18.00	90 00	NO NEED	1.00
205	2	0.06250	DCEN(SP)	150	18.00	90 00	NO NEED	1.00
206	2	0.06250	DCEN(SP)	150	18.00	90 00	NO NEED	1.00
207	2	0.06250	DCEN(SP)	150	18.00	90 00	NO NEED	1.00
208	6	0.06250	DCEN(SP)	180	19.00	115 00	NO NEED	1.00
209	6	0.06250	DCEN(SP)	180	19.00	115 00	NO NEED	1.00
210	6	0.06250	DCEN(SP)	180	19.00	115 00	NO NEED	1.00
211	6	0.06250	DCEN(SP)	180	19.00	115 00	NO NEED	1.00
212	6	0.06250	DCEN(SP)	180	19.00	115 00	NO NEED	1.00
213	8	0.06250	DCEN(SP)	170	19.00	105 00	NO NEED	1.00
214	8	0.06250	DCEN(SP)	170	19.00	105 00	NO NEED	1.00
215	8	0.06250	DCEN(SP)	170	19.00	105 00	NO NEED	1.00
216	8	0.06250	DCEN(SP)	170	19.00	105 00	NO NEED	1.00
217	8	0.06250	DCEN(SP)	170	19.00	105 00	NO NEED	1.00
218	1	0.09375	DCEP(RP)	300	27.50	190 00	NO NEED	1.00
219	2	0.09375	DCEP(RP)	300	27.50	170 00	NO NEED	1.00
220	2	0.09375	DCEP(RP)	300	27.50	170 00	NO NEED	1.00
221	2	0.09375	DCEP(RP)	300	27.50	170 00	NO NEED	1.00
222	4	0.09375	DCEP(RP)	300	27.50	170 00	NO NEED	1.00
223	6	0.09375	DCEP(RP)	300	27.50	170 00	NO NEED	1.00
224	8	0.09375	DCEP(RP)	300	27.50	170 00	NO NEED	1.00
225	3	0.09375	DCEP(RP)	300	27.50	170 00	NO NEED	1.00

PAWSHGAS.DBF (Shielding gases for PAW)

Is_name → / ds ↓	Ist wall (Material)	Lower (WT_lower)	Upper (WT_upper)	Shielding (Shield_gas)	Orifice (Orific_gas)
1	Al	0.0000	0.0625	Ar , He	PURE ARGON
2	Al	0.0625	100.0000	He	PURE ARGON
3	Alal	0.0000	0.0625	Ar , He	PURE ARGON
4	Alal	0.0625	100.0000	He	PURE ARGON
5	LCS	0.0000	0.0625	Ar , 25% He + 75% Ar	PURE ARGON
6	LCS	0.0625	100.0000	Ar , 75% He + 25% Ar	PURE ARGON
7	MCS	0.0000	0.0625	Ar , 25% He + 75% Ar	PURE ARGON
8	HCS	0.0000	0.0625	Ar , 25% He + 75% Ar	PURE ARGON
9	TS	0.0000	0.0625	Ar , 25% He + 75% Ar	PURE ARGON
10	AS	0.0000	0.0625	Ar , 25% He + 75% Ar	PURE ARGON
11	MCS	0.0625	100.0000	Ar , 75% He + 25% Ar	PURE ARGON
12	HCS	0.0625	100.0000	Ar , 75% He + 25% Ar	PURE ARGON
13	TS	0.0625	100.0000	Ar , 75% He + 25% Ar	PURE ARGON
14	AS	0.0625	100.0000	Ar,He,Ar+HYDROGEN(1-5%)	PURE ARGON
15	GCI	0.0000	100.0000	Ar	PURE ARGON
16	MCI	0.0000	100.0000	Ar	PURE ARGON
17	SS	0.0000	100.0000	Ar,He,Ar+HYDROGEN (1-5%)	PURE ARGON
18	Cu	0.0000	0.0625	25%He+75%Ar,He,75%He+25%Ar	PURE ARGON
19	Cu+Zn	0.0000	0.0625	25%He+75%Ar,He,75%He+25%Ar	PURE ARGON
20	Cu+Sn	0.0000	0.0625	25%He+75%Ar,He,75%He+25%Ar	PURE ARGON
21	Cu+Zn+Ni	0.0000	0.0625	25% He+75% Ar,He,75% He+25% Ar	PURE ARGON
22	Cu+Al	0.0000	0.0625	25% He+75% Ar,He,75% He+25% Ar	PURE ARGON
23	Cu+Si	0.0000	0.0625	25% He+75% Ar,He,75% He+25% Ar	PURE ARGON
24	Cu+Ni	0.0000	0.0625	25% He+75% Ar,He,75% He+25% Ar	PURE ARGON
25	Cu	0.0625	100.0000	He	PURE ARGON
26	Cu+Zn	0.0625	100.0000	He	PURE ARGON
27	Cu+Zn+Ni	0.0625	100.0000	He	PURE ARGON
28	Cu+Sn	0.0625	100.0000	He	PURE ARGON
29	Cu+Al	0.0625	100.0000	He	PURE ARGON
30	Cu+Si	0.0625	100.0000	He	PURE ARGON
31	Cu+Ni	0.0625	100.0000	He	PURE ARGON
32	Mg	0.0000	100.0000	Ar , Ar + He	PURE ARGON
33	Ni	0.0000	100.0000	Ar , He , Ar + HYDROGEN (1-5%)	PURE ARGON
34	Ni+Cr+Fe	0.0000	100.0000	Ar , He , Ar + HYDROGEN (1-5%)	PURE ARGON
35	Ni+Cu	0.0000	100.0000	Ar , He , Ar + HYDROGEN (1-5%)	PURE ARGON
36	Nm	0.0000	100.0000	Ar , He , Ar + HYDROGEN (1-5%)	PURE ARGON
37	Ta	0.0000	100.0000	Ar	PURE ARGON
38	W	0.0000	100.0000	Ar , He	PURE ARGON
39	Co	0.0000	100.0000	Ar , He	PURE ARGON
40	Ti	0.0000	0.0625	Ar	PURE ARGON
41	Ti	0.0625	100.0000	Ar , 75% He + 25% Ar	PURE ARGON
42	Tial	0.0000	0.0625	Ar	PURE ARGON
43	Tial	0.0625	100.0000	Ar , 75% He + 25% Ar	PURE ARGON
44	Zr	0.0000	0.0625	Ar	PURE ARGON
45	Hf	0.0000	0.0625	Ar	PURE ARGON
46	Be	0.0000	0.0625	Ar	PURE ARGON
47	Zr	0.0625	100.0000	Ar , 75% He + 25% Ar	PURE ARGON
48	Hf	0.0625	100.0000	Ar , 75% He + 25% Ar	PURE ARGON
49	Be	0.0625	100.0000	Ar , 75% He + 25% Ar	PURE ARGON
50	Cr	0.0000	100.0000	Ar , He	PURE ARGON

PAWPARA.DBF (Welding parameters for PAW)

Fields_name → / Records ↓	Material	Material thickness	Travel speed	Polarity	Current	Voltage	Dia. orifice	Shielding gas flow rate	Orifice gas flow rate	Number passes
	(Motation1)	(MT_incl	(Tr_speedX	Polarity)	Curr_amps)	Voltage	(Orfic_diaX	Shgas_flr)	Orgas_flr)	(No_passes)
1	LCS	0.0300	26	DCEN(SP)	45	25	0.081	20	0.5	1
2	MCS	0.0300	26	DCEN(SP)	45	25	0.081	20	0.5	1
3	HCS	0.0300	26	DCEN(SP)	45	25	0.081	20	0.5	1
4	TS	0.0300	26	DCEN(SP)	45	25	0.081	20	0.5	1
5	AS	0.0300	26	DCEN(SP)	45	25	0.081	20	0.5	1
6	LCS	0.0800	17	DCEN(SP)	55	25	0.081	20	1	1
7	MCS	0.0800	17	DCEN(SP)	55	25	0.081	20	1	1
8	HCS	0.0800	17	DCEN(SP)	55	25	0.081	20	1	1
9	TS	0.0800	17	DCEN(SP)	55	25	0.081	20	1	1
10	AS	0.0800	17	DCEN(SP)	55	25	0.081	20	1	1
11	LCS	0.1250	12	DCEN(SP)	185	28	0.111	60	13	1
12	MCS	0.1250	12	DCEN(SP)	185	28	0.111	60	13	1
13	HCS	0.1250	12	DCEN(SP)	185	28	0.111	60	13	1
14	TS	0.1250	12	DCEN(SP)	185	28	0.111	60	13	1
15	AS	0.1250	12	DCEN(SP)	185	28	0.111	60	13	1
16	LCS	0.1700	10	DCEN(SP)	200	29	0.136	60	12	1
17	MCS	0.1700	10	DCEN(SP)	200	29	0.136	60	12	1
18	HCS	0.1700	10	DCEN(SP)	200	29	0.136	60	12	1
19	TS	0.1700	10	DCEN(SP)	200	29	0.136	60	12	1
20	AS	0.1700	10	DCEN(SP)	200	29	0.136	60	12	1
21	LCS	0.2500	14	DCEN(SP)	275	33	0.136	60	15	1
22	MCS	0.2500	14	DCEN(SP)	275	33	0.136	60	15	1
23	HCS	0.2500	14	DCEN(SP)	275	33	0.136	60	15	1
24	TS	0.2500	14	DCEN(SP)	275	33	0.136	60	15	1
25	AS	0.2500	14	DCEN(SP)	275	33	0.136	60	15	1
26	SS	0.0080	7	DCEN(SP)	12	25	0.093	20	0.5	1
27	SS	0.0200	21	DCEN(SP)	12	27	0.046	20	0.5	1
28	SS	0.0300	17	DCEN(SP)	34	27	0.046	20	0.5	1
29	SS	0.0620	14	DCEN(SP)	65	28	0.081	20	0.70	1
30	SS	0.0930	24	DCEN(SP)	115	30	0.111	35	6	1
31	SS	0.1250	30	DCEN(SP)	145	32	0.111	35	10	1
32	SS	0.1870	16	DCEN(SP)	165	36	0.136	45	13	1
33	SS	0.2500	14	DCEN(SP)	240	38	0.136	50	18	1
34	Al	0.0360	24	DCEP(RP)	47	22	0.081	20	0.05	1
35	Al	0.0500	22	DCEP(RP)	48	22	0.081	20	0.50	1
36	Al	0.0900	4	DCEP(RP)	34	22	0.081	20	1.4	1
37	Alal	0.0360	24	DCEP(RP)	47	22	0.081	20	0.05	1
38	Alal	0.0500	22	DCEP(RP)	48	22	0.081	20	0.5	1
39	Alal	0.0900	4	DCEP(RP)	34	22	0.081	20	1.4	1
40	Ti	0.1250	20	DCEN(SP)	185	21	0.111	60	8	1
41	Tial	0.1250	20	DCEN(SP)	185	21	0.111	60	8	1
42	Ti	0.1870	13	DCEN(SP)	175	25	0.136	60	18	1
43	Tial	0.1870	13	DCEN(SP)	175	25	0.136	60	18	1
44	Ti	0.3900	10	DCEN(SP)	225	38	0.136	60	32	1
45	Tial	0.3900	10	DCEN(SP)	225	38	0.136	60	32	1
46	Ti	0.5000	10	DCEN(SP)	270	36	0.136	60	27	1
47	Tial	0.5000	10	DCEN(SP)	270	36	0.136	60	27	1

MIGSHGAS.DBF (Shielding gases for MIG_SPRAY & MIG_PULSED)

Fields name →	(Material)	Lower (MI_lower)	Upper (MI_upper)	Shielding gas (Shield_gas)	Advantage (Advantage)
1	Al	0.0000	1.0000	ARGON	LEAST SPATTER
2	Al	1.0000	3.0000	35%ARGON+65%HELIUM	HIGHER HEAT INPUT
3	Al	3.0000	100.0000	25%ARGON+75%HELIUM	HIGHEST HEAT INPUT , MINIMIZES POROSITY
4	Alal	0.0000	1.0000	ARGON	LEAST SPATTER
5	Alal	1.0000	3.0000	35%ARGON+65%HELIUM	HIGHER HEAT INPUT
6	Alal	3.0000	100.0000	25%ARGON+75%HELIUM	HIGHEST HEAT INPUT , MINIMIZES POROSITY
7	Mg	0.0000	100.0000	ARGON	EXCELLENT CLEANING ACTION
8	GCI	0.0000	100.0000	ARGON	EXCELLENT CLEANING ACTION
9	MCI	0.0000	100.0000	ARGON	EXCELLENT CLEANING ACTION
10	LCS	0.0000	100.0000	ARGON+3-5%OXYGEN	EXCELLENT COALESCENCE , CONTROLLABLE WELD PUDDLE
11	LCS	0.0000	100.0000	CARBON DIOXIDE	GOOD COALESCENCE , CONTROLLABLE WELD PUDDLE
12	MCS	0.0000	100.0000	CARBON DIOXIDE	HIGH SPEED MECHANIZED WELDING , LOW COST WELDING
13	HCS	0.0000	100.0000	CARBON DIOXIDE	HIGH SPEED MECHANIZED WELDING , LOW COST WELDING
14	TS	0.0000	100.0000	CARBON DIOXIDE	HIGH SPEED MECHANIZED WELDING , LOW COST WELDING
15	CS	0.0000	100.0000	CARBON DIOXIDE	HIGH SPEED MECHANIZED WELDING , LOW COST WELDING
16	MCS	0.0000	100.0000	ARGON+3-5%OXYGEN	HIGH SPEED MECHANIZED WELDING , LOW COST WELDING
17	HCS	0.0000	100.0000	ARGON+3-5%OXYGEN	GOOD COALESCENCE , CONTROLLABLE WELD PUDDLE
18	TS	0.0000	100.0000	ARGON+3-5%OXYGEN	GOOD COALESCENCE , CONTROLLABLE WELD PUDDLE
19	CS	0.0000	100.0000	ARGON+3-5%OXYGEN	GOOD COALESCENCE , CONTROLLABLE WELD PUDDLE
20	AS	0.0000	100.0000	ARGON+2%OXYGEN	GOOD COALESCENCE , CONTROLLABLE WELD PUDDLE
21	SS	0.0000	100.0000	ARGON+1%OXYGEN	GOOD TOUGHNESS , MINIMIZES UNDERCUTTING
22	SS	0.0000	100.0000	ARGON+2%OXYGEN	GOOD COALESCENCE , CONTROLLABLE WELD PUDDLE
23	Cu	0.0000	0.1250	ARGON	BETTER COALESCENCE , BETTER ARC STABILITY
24	Cu+Ni	0.0000	0.1250	ARGON	GOOD WETTING
25	Cu+Zn+Ni	0.0000	0.1250	ARGON	GOOD WETTING
26	Cu+Zn	0.0000	0.1250	ARGON	GOOD WETTING
27	Cu+Sn	0.0000	0.1250	ARGON	GOOD WETTING
28	Cu+Si	0.0000	0.1250	ARGON	GOOD WETTING
29	Cu+Al	0.0000	0.1250	ARGON	GOOD WETTING
30	Ni	0.0000	0.1250	ARGON	GOOD WETTING
31	Ni+Cu	0.0000	0.1250	ARGON	GOOD WETTING
32	Ni+Cr+Fe	0.0000	0.1250	ARGON	GOOD WETTING
33	Nm	0.0000	0.1250	ARGON	GOOD WETTING
34	Cu	0.1250	100.0000	ARGON+HELIUM	HIGHER HEAT INPUT
35	Cu+Ni	0.1250	100.0000	ARGON+HELIUM	HIGHER HEAT INPUT
36	Cu+Zn+Ni	0.1250	100.0000	ARGON + HELIUM	HIGHER HEAT INPUT
37	Cu+Zn	0.1250	100.0000	ARGON + HELIUM	HIGHER HEAT INPUT
38	Cu+Sn	0.1250	100.0000	ARGON + HELIUM	HIGHER HEAT INPUT
39	Cu+Si	0.1250	100.0000	ARGON + HELIUM	HIGHER HEAT INPUT
40	Cu+Al	0.1250	100.0000	ARGON + HELIUM	HIGHER HEAT INPUT
41	Ni	0.1250	100.0000	ARGON + HELIUM	HIGHER HEAT INPUT
42	Ni+Cu	0.1250	100.0000	ARGON + HELIUM	HIGHER HEAT INPUT
43	Ni+Cr+Fe	0.1250	100.0000	ARGON + HELIUM	HIGHER HEAT INPUT
44	Nm	0.1250	100.0000	ARGON + HELIUM	HIGHER HEAT INPUT
45	Ti	0.0000	100.0000	ARGON	GOOD ARC STABILITY
46	Tial	0.0000	100.0000	ARGON	GOOD ARC STABILITY
47	Ag	0.0000	100.0000	ARGON	GOOD ARC STABILITY
48	Pt	0.0000	100.0000	ARGON	GOOD ARC STABILITY
49	Zr	0.0000	100.0000	ARGON	GOOD ARC STABILITY
50	Hf	0.0000	100.0000	ARGON	GOOD ARC STABILITY
51	Ta	0.0000	100.0000	ARGON	GOOD ARC STABILITY
52	Be	0.0000	100.0000	ARGON	GOOD ARC STABILITY
53	Mo	0.0000	100.0000	ARGON OR HELIUM	GOOD ARC STABILITY
54	W	0.0000	100.0000	ARGON OR HELIUM	GOOD ARC STABILITY

DMIGSHGAS.DBF (Shielding gases for MIG_SHORT-DIP)

Records	(Material)	Lower (Lower)	Upper (Upper)	Shielding (Shield_gas)	Advantage (Advantage)
1	Al	0.0000	100.0000	ARGON OR (ARGON + HELIUM)	Ar FOR SHEET MATERIAL , Ar+He FOR THICKER SHEET
2	Alal	0.0000	100.0000	ARGON OR (ARGON + HELIUM)	Ar FOR SHEET MATERIAL , Ar+He FOR THICKER SHEET
3	Mg	0.0000	100.0000	ARGON OR (ARGON + HELIUM)	Ar FOR SHEET MATERIAL , Ar+He FOR THICKER SHEET
4	Ni	0.0000	100.0000	ARGON OR (ARGON + HELIUM)	Ar FOR SHEET MATERIAL , Ar+He FOR THICKER SHEET
5	Ni+Cu	0.0000	100.0000	ARGON OR (ARGON + HELIUM)	Ar FOR SHEET MATERIAL , Ar+He FOR THICKER SHEET
6	Ni+Cr+Fe	0.0000	100.0000	ARGON OR (ARGON + HELIUM)	Ar FOR SHEET MATERIAL , Ar+He FOR THICKER SHEET
7	Nm	0.0000	100.0000	ARGON OR (ARGON + HELIUM)	Ar FOR SHEET MATERIAL , Ar+He FOR THICKER SHEET
8	Cu	0.0000	100.0000	ARGON OR (ARGON + HELIUM)	Ar FOR SHEET MATERIAL , Ar+He FOR THICKER SHEET
9	Cu+Ni	0.0000	100.0000	ARGON OR (ARGON + HELIUM)	Ar FOR SHEET MATERIAL , Ar+He FOR THICKER SHEET
10	Cu+Zn+Ni	0.0000	100.0000	ARGON OR (ARGON + HELIUM)	Ar FOR SHEET MATERIAL , Ar+He FOR THICKER SHEET
11	Cu+Zn	0.0000	100.0000	ARGON OR (ARGON + HELIUM)	Ar FOR SHEET MATERIAL , Ar+He FOR THICKER SHEET
12	Cu+Sn	0.0000	100.0000	ARGON OR (ARGON + HELIUM)	Ar FOR SHEET MATERIAL , Ar+He FOR THICKER SHEET
13	Cu+Si	0.0000	100.0000	ARGON OR (ARGON + HELIUM)	Ar FOR SHEET MATERIAL , Ar+He FOR THICKER SHEET
14	Cu+Al	0.0000	100.0000	ARGON OR (ARGON + HELIUM)	Ar FOR SHEET MATERIAL , Ar+He FOR THICKER SHEET
15	LCS	0.0000	0.1250	75% ARGON + 25% CARBON DIOXIDE	MINIMUM DISTORTION AND SPATTER
16	MCS	0.0000	0.1250	75% ARGON + 25% CARBON DIOXIDE	MINIMUM DISTORTION AND SPATTER
17	HCS	0.0000	0.1250	75% ARGON + 25% CARBON DIOXIDE	MINIMUM DISTORTION AND SPATTER
18	TS	0.0000	0.1250	75% ARGON + 25% CARBON DIOXIDE	MINIMUM DISTORTION AND SPATTER
19	CS	0.0000	0.1250	75% ARGON + 25% CARBON DIOXIDE	MINIMUM DISTORTION AND SPATTER
20	LCS	0.1250	100.0000	50% ARGON + 50% CARBON DIOXIDE	MINIMUM SPATTER & CLEAN WELD APPEARANCE
21	MCS	0.1250	100.0000	50% ARGON + 50% CARBON DIOXIDE	MINIMUM SPATTER & CLEAN WELD APPEARANCE
22	HCS	0.1250	100.0000	50% ARGON + 50% CARBON DIOXIDE	MINIMUM SPATTER & CLEAN WELD APPEARANCE
23	TS	0.1250	100.0000	50% ARGON + 50% CARBON DIOXIDE	MINIMUM SPATTER & CLEAN WELD APPEARANCE
24	CS	0.1250	100.0000	50% ARGON + 50% CARBON DIOXIDE	MINIMUM SPATTER & CLEAN WELD APPEARANCE
25	LCS	0.0000	100.0000	CARBON DIOXIDE	FASTER WELDING SPEED , LOW COST
26	MCS	0.0000	100.0000	CARBON DIOXIDE	FASTER WELDING SPEED , LOW COST
27	HCS	0.0000	100.0000	CARBON DIOXIDE	FASTER WELDING SPEED , LOW COST
28	TS	0.0000	100.0000	CARBON DIOXIDE	FASTER WELDING SPEED , LOW COST
29	CS	0.0000	100.0000	CARBON DIOXIDE	FASTER WELDING SPEED , LOW COST
30	BS	0.0000	100.0000	90% HELIUM + 7.5% ARGON + 2.5% CARBON DIOXIDE	NO UNDERCUTTING , MINIMUM DISTORTION
31	AS	0.0000	100.0000	60%-70%HELIUM+25%-35%ARGON+4-5%CARBON DIOXIDE	EXCELLENT TOUGHNESS,LITTLE SPATTER
32	AS	0.0000	100.0000	75% ARGON + 25% CARBON DIOXIDE	FAIR TOUGHNESS
33	Ag	0.0000	100.0000	PURE ARGON	NOTHING SPECIAL

34	Pt	0.0000	100.0000 PURE ARGON	NOTHING SPECIAL
35	Ta	0.0000	100.0000 PURE ARGON	NOTHING SPECIAL
36	Be	0.0000	100.0000 PURE ARGON	NOTHING SPECIAL
37	Zr	0.0000	100.0000 PURE ARGON	NOTHING SPECIAL
38	Hf	0.0000	100.0000 PURE ARGON	NOTHING SPECIAL
39	GCI	0.0000	100.0000 PURE ARGON	NOTHING SPECIAL
40	MCI	0.0000	100.0000 PURE ARGON	NOTHING SPECIAL
41	Ti	0.0000	100.0000 PURE ARGON	NOTHING SPECIAL
42	Tial	0.0000	100.0000 PURE ARGON	NOTHING SPECIAL
43	Mo	0.0000	100.0000 ARGON OR HELIUM	NOTHING SPECIAL
44	W	0.0000	100.0000 ARGON OR HELIUM	NOTHING SPECIAL

MIGPARA.DBF (Welding parameters for MIG)

name →	Material Notation (Notation1)	Working Thickness (WT_inch)	Dia of Filler Material (Dia_fm)	Polarity (Polarity)	Current (Curr_amps)	Voltage (Voltage)	Filler Material Feed Rate (FM_frate)	Gas Flow Rate (Gas_flrate)	Number of passes (No_passes)	Travel Speed (Tr_speed)
1	Al	0.04687	0.03000	DCEP(RP)	50	12-14	268-308	30	1	17-25
2	Al	0.07813	0.03000	DCEP(RP)	55-60	12-14	295-320	30	1	17-25
3	Al	0.07813	0.04687	DCEP(RP)	110-125	19-21	175-185	30	1	20-27
4	Al	0.09375	0.03000	DCEP(RP)	90-100	14-18	330-370	30	1	24-36
5	Al	0.12500	0.03000	DCEP(RP)	110-125	19-22	410-460	30	1	20-24
6	Al	0.12500	0.04687	DCEP(RP)	110-125	20-24	175-190	40	1	20-24
7	Al	0.18750	0.04687	DCEP(RP)	160-195	20-24	215-225	40	1	20-25

CONTINUED. (PTO)

8	Al	0.25000	0.04687	DCEP(RP)	160-195	20-24	215-225	40	1	20-25
9	Al	0.25000	0.06250	DCEP(RP)	175-225	22-26	150-195	40	3	20-25
10	Al	0.37500	0.06250	DCEP(RP)	200-300	22-26	170-275	40	2-5	25-30
11	Al	0.50000	0.06250	DCEP(RP)	220-230	22-27	195-205	40	3-8	12-18
12	Al	0.50000	0.09375	DCEP(RP)	320-340	22-29	140-150	45	2-5	15-17
13	Al	0.75000	0.06250	DCEP(RP)	255-275	22-27	230-250	50	4-10	8-18
14	Al	0.75000	0.09375	DCEP(RP)	355-375	22-29	155-160	50	4-10	4-16
15	Al	1.00000	0.06250	DCEP(RP)	255-290	22-27	230-265	50	4-14	6-18
16	Al	1.00000	0.09375	DCEP(RP)	405-425	22-27	175-180	50	4-8	8-12
17	Alal	0.06250	0.03500	DCEP(RP)	55-60	13-14	250-300	15	1	12-24
18	Alal	0.09375	0.03500	DCEP(RP)	90-100	16-18	300-350	30	1	24-36
19	Alal	0.12500	0.04687	DCEP(RP)	110-130	19-21	160-200	35	1	22-26
20	Alal	0.18750	0.04687	DCEP(RP)	150-190	19-21	225-275	35	1	20-25
21	Alal	0.25000	0.06250	DCEP(RP)	175-225	20-22	150-190	35	1	20-25
22	Alal	0.37500	0.06250	DCEP(RP)	200-250	21-26	170-210	40	2	24-30
23	Alal	0.50000	0.06250	DCEP(RP)	200-250	24-29	170-210	50	3-5	12-18
24	Alal	0.50000	0.09375	DCEP(RP)	240-280	26-28	140-150	45	2-3	15-20
25	Alal	0.75000	0.06250	DCEP(RP)	250-300	22-27	230-260	50	4-8	10-16
26	Alal	0.75000	0.09375	DCEP(RP)	280-320	27-29	150-160	50	3-4	10-16
27	Alal	1.00000	0.09375	DCEP(RP)	280-320	27-29	150-160	50	5-6	14-26
28	Alal	1.00000	0.06250	DCEP(RP)	250-300	22-27	230-260	50	6-10	8-14
29	Cu	0.12500	0.06250	DCEP(RP)	310	27	450	30	1	30
30	Cu	0.12500	0.06250	DCEP(RP)	325-350	28-33	450	32	1	30
31	Cu	0.18750	0.04500	DCEP(RP)	210	25	240	30	1	25
32	Cu	0.25000	0.09375	DCEP(RP)	460	26	250	30	2	20
33	Cu	0.25000	0.09375	DCEP(RP)	500	27	250	30	1	20
34	Cu	0.25000	0.06250	DCEP(RP)	400-425	32-36	250	32	2	N.AV.
35	Cu	0.37500	0.09375	DCEP(RP)	500	27	N.AV.	30	N.AV.	14
36	Cu	0.37500	0.09375	DCEP(RP)	550	27	N.AV.	30	N.AV.	14
37	Cu	0.50000	0.06250	DCEP(RP)	425-450	30-35	N.AV.	32	4	N.AV.
38	Cu	0.50000	0.09375	DCEP(RP)	540	27	N.AV.	30	N.AV.	14
39	Cu	0.50000	0.09375	DCEP(RP)	600	27	N.AV.	30	N.AV.	10
40	Cu+Zn	0.12500	0.06250	DCEP(RP)	275-285	27	400	30	1	N.AV.
41	Cu+Sn	0.12500	0.06250	DCEP(RP)	275-285	27	400	30	1	N.AV.
42	Cu+Zn+Ni	0.12500	0.06250	DCEP(RP)	275-285	27	400	30	1	N.AV.
43	Cu+Zn	0.37500	0.06250	DCEP(RP)	275-285	27	400	30	2	N.AV.
44	Cu+Sn	0.37500	0.06250	DCEP(RP)	275-285	27	400	30	2	N.AV.
45	Cu+Zn+Ni	0.37500	0.06250	DCEP(RP)	275-285	27	400	30	2	N.AV.
46	Cu+Zn	0.50000	0.06250	DCEP(RP)	275-285	27	400	30	4	N.AV.
47	Cu+Sn	0.50000	0.06250	DCEP(RP)	275-285	27	400	30	4	N.AV.
48	Cu+Zn+Ni	0.50000	0.06250	DCEP(RP)	275-285	27	400	30	4	N.AV.
49	Cu+Al	0.12500	0.06250	DCEP(RP)	280-290	28	430	30	1	N.AV.
50	Cu+Al	0.37500	0.06250	DCEP(RP)	280-290	28	240	30	2	N.AV.
51	Cu+Al	0.50000	0.06250	DCEP(RP)	280-290	28	200	30	3	N.AV.
52	Cu+Si	0.12500	0.06250	DCEP(RP)	260-270	28	430	30	1	N.AV.
53	Cu+Si	0.37500	0.06250	DCEP(RP)	260-270	28	240	30	2	N.AV.
54	Cu+Si	0.50000	0.06250	DCEP(RP)	260-270	28	200	30	3	N.AV.
55	Cu+Ni	0.12500	0.06250	DCEP(RP)	280	28	400	30	1	N.AV.
56	Cu+Ni	0.37500	0.06250	DCEP(RP)	280	28	240	30	2	N.AV.
57	Cu+Ni	0.50000	0.06250	DCEP(RP)	280	28	200	30	4	N.AV.
58	Mg	0.02500	0.04000	DCEP(RP)	25	13	140	50	1	N.AV.
59	Mg	0.04000	0.04000	DCEP(RP)	40	14	230	50	1	N.AV.
60	Mg	0.06300	0.06300	DCEP(RP)	70	14	185	50	1	N.AV.
61	Mg	0.06300	0.04000	DCEP(RP)	50	21	360	50	1	N.AV.
62	Mg	0.09000	0.06300	DCEP(RP)	95	16	245	50	1	N.AV.
63	Mg	0.12500	0.09400	DCEP(RP)	115	14	135	50	1	N.AV.
64	Mg	0.12500	0.06300	DCEP(RP)	110	24	280	50	1	N.AV.
65	Mg	0.16000	0.09400	DCEP(RP)	135	15	165	50	1	N.AV.
66	Mg	0.19000	0.09400	DCEP(RP)	175	15	205	50	1	N.AV.
67	Mg	0.19000	0.06300	DCEP(RP)	175	25	475	50	1	N.AV.
68	Mg	0.25000	0.09400	DCEP(RP)	210	29	290	50	1	N.AV.
69	Mg	0.25000	0.06300	DCEP(RP)	240	27	530	50	1	N.AV.
70	Mg	0.37500	0.09400	DCEP(RP)	320-350	24-30	285-310	65	1	N.AV.
71	Mg	0.50000	0.09400	DCEP(RP)	360-400	24-30	320-360	65	2	N.AV.
72	Mg	0.62500	0.09400	DCEP(RP)	370-420	24-30	330-370	65	2	N.AV.
73	Mg	1.00000	0.09400	DCEP(RP)	370-420	24-30	330-370	65	4	N.AV.

OTMIGPARA.DBF (Welding parameters for MIG) PART I

Fields name → / Records ↓	Welding position (Weld_posi)	Working thickness (WT_inch)	Dia. of filler materials (Dia_fm)	Polarity (Polarity)	Root bead current (Rbeed_curr)	Root bead travel speed (Rbeed_trsp)	Number of filler beed (Fbeed_no)
1	FLAT(1G)	0.25000	0.04700	DCEP(RP)	280	31.5	0
2	FLAT(1G)	0.25000	0.04700	DCEP(RP)	280	31.5	0
3	FLAT(1G)	0.37500	0.04700	DCEP(RP)	280	20	0
4	FLAT(1G)	0.37500	0.06200	DCEP(RP)	270	24.5	1
5	FLAT(1G)	0.50000	0.06200	DCEP(RP)	280	20	2
6	FLAT(1G)	0.62000	0.06200	DCEP(RP)	320	16.5	2
7	FLAT(1G)	0.75000	0.06200	DCEP(RP)	340	16	2
8	FLAT(1G)	1.00000	0.06200	DCEP(RP)	340	17	3
9	FLAT(1G)	1.25000	0.09300	DCEP(RP)	400	16	3
10	FLAT(1G)	1.50000	0.09300	DCEP(RP)	440	16	4
11	HORIZONTAL(2G)	0.25000	0.04700	DCEP(RP)	85	14.5	2
12	HORIZONTAL(2G)	0.37500	0.04700	DCEP(RP)	80	14.5	3
13	HORIZONTAL(2G)	0.50000	0.06200	DCEP(RP)	120	11	5
14	HORIZONTAL(2G)	0.75000	0.06200	DCEP(RP)	120	11	8
15	HORIZONTAL(2G)	1.00000	0.06200	DCEP(RP)	125	11	11
16	VERTICAL(3G)	0.25000	0.04700	DCEP(RP)	150	20	2
17	VERTICAL(3G)	0.37500	0.04700	DCEP(RP)	150	18	2
18	VERTICAL(3G)	0.50000	0.06200	DCEP(RP)	210	8	4
19	VERTICAL(3G)	0.62500	0.06200	DCEP(RP)	225	9.5	3
20	VERTICAL(3G)	0.75000	0.06200	DCEP(RP)	225	8	3
21	VERTICAL(3G)	1.00000	0.06200	DCEP(RP)	225	8	6
22	VERTICAL(3G)	1.25000	0.06200	DCEP(RP)	225	8	6
23	VERTICAL(3G)	1.50000	0.06200	DCEP(RP)	225	8	10

OTMIGPARA.DBF (Welding parameters for MIG) PART II

Fields name → / Records ↓	Filler beed current (Fbeed_curr)	Filler beed travel speed (Fbeed_trsp)	Total beed (Total_beed)
1	0	0	1
2	0	0	1
3	0	0	1
4	270(1)	22(1)	2
5	255(1),260(1)	18(1),20(1)	3
6	270(1),270(1)	15(1),15(1)	3
7	300(1),295(1)	15(1),15(1)	3
8	300(3)	13(2),12.5(1)	4
9	360(3)	10(1),11(1),16(1)	4
10	360(2),370(1),350(1)	10(1),11(1),16(1)	5
11	100(2)	16(1),18(1)	3
12	105(1),155(2)	16(2),22.5(1)	4
13	245(4),210(1)	24(3),18.5(1),24(1)	6
14	225(7),210(1)	18.5-20(7),22(1)	9
15	230(1),240(9),210(1)	22(1),18-20(9),26(1)	12
16	135(2)	21.5(2)	3
17	125(2)	18(2)	3
18	200(4)	10-11(4)	5
19	220(1),190(2)	9.5(1),13(1),14(1)	4
20	220(3)	9.5(2),8(1)	4
21	220(4),190(2)	9.5(4),8(2)	7
22	220(4),195(2)	8(4),7(2)	7
23	225(6),220(2),190(2)	9.5(6),12(2),9.5(2)	11

OTTIGPARA.DBF (Welding parameters for TIG)

Name→	Thickness (WT_inch)	Number of passes (NB_passes)	Dia. of electrode (Dia_ELEC)	Dia. of filler (Dia_FM)	Polarity (Polarity)	Gas flow rate (Gas_rate)	Current (Curr_amps)	Travel speed (Tr_speed)
1	0.05000	1	0.06250	0.06250	DCEN(SP)	19	40-60	16
2	0.06250	1	0.09375	0.09375	DCEN(SP)	19	70-90	15
3	0.09375	1	0.09375	0.09375	DCEN(SP)	18	90-115	10
4	0.12500	1	0.12500	0.12500	DCEN(SP)	19	115-140	10
5	0.18750	1-2	0.15625	0.18750	DCEN(SP)	25	160-200	10
6	0.25000	1-2	0.18750	0.18750	DCEN(SP)	30	200-250	9
7	0.37500	2	0.18750	0.18750	DCEN(SP)	33	240-310	8
8	0.50000	2-3	0.18750	0.18750	DCEN(SP)	35	300-350	8

TIGPARA.DBF (Welding parameters for TIG)

Name ▶	Material (Notation	Thickness (HT_lower)	Thickness (HT_upper)	Dia. electrode (Dia_elec)	Dia. filler (Dia_fil	Number passes (No_passes)	Polarity (Polarity	Current (Curr_amps)	Voltage (Voltage)	Travel (Tr_speed)	Gas flow (cu_ft/hr) (Gas_flrate)	H (P
1	LCS	0.0468	0.1250	0.09375	0.06250	1	DCEN(SP)	50-100	12	AS REQUIRED	20	
2	MCS	0.0625	0.1250	0.09375	0.06250	1	DCEN(SP)	50-100	12	AS REQUIRED	20	
3	HCS	0.0625	0.1250	0.09375	0.06250	1	DCEN(SP)	50-100	12	AS REQUIRED	20	
4	TI	0.0468	0.1250	0.09375	0.06250	1	DCEN(SP)	50-100	12	AS REQUIRED	20	
5	AS	0.0625	0.1250	0.09375	0.06250	1	DCEN(SP)	50-100	12	AS REQUIRED	20	
6	CS	0.0625	0.1250	0.09375	0.06250	1	DCEN(SP)	50-100	12	AS REQUIRED	20	
7	LCS	0.1250	0.2500	0.09375	0.09375	1	DCEN(SP)	70-120	12	AS REQUIRED	20	
8	MCS	0.1250	0.2500	0.09375	0.09375	1	DCEN(SP)	70-120	12	AS REQUIRED	20	
9	HCS	0.1250	0.2500	0.09375	0.09375	1	DCEN(SP)	70-120	12	AS REQUIRED	20	
10	TS	0.1250	0.2500	0.09375	0.09375	1	DCEN(SP)	70-120	12	AS REQUIRED	20	
11	AS	0.1250	0.2500	0.09375	0.09375	1	DCEN(SP)	70-120	12	AS REQUIRED	20	
12	CS	0.1250	0.2500	0.09375	0.09375	1	DCEN(SP)	70-120	12	AS REQUIRED	20	
13	LCS	0.2500	0.5000	0.12500	0.12500	1	DCEN(SP)	90-150	12	AS REQUIRED	25	
14	MCS	0.2500	0.5000	0.12500	0.12500	1	DCEN(SP)	90-150	12	AS REQUIRED	25	
15	HCS	0.2500	0.5000	0.12500	0.12500	1	DCEN(SP)	90-150	12	AS REQUIRED	25	
16	TS	0.2500	0.5000	0.12500	0.12500	1	DCEN(SP)	90-150	12	AS REQUIRED	25	
17	AS	0.2500	0.5000	0.12500	0.12500	1	DCEN(SP)	90-150	12	AS REQUIRED	25	
18	CS	0.2500	0.5000	0.12500	0.12500	1	DCEN(SP)	90-150	12	AS REQUIRED	25	
19	SS	0.0625	0.0625	0.06250	0.06250	1	DCEN(SP)	70-120	12	11	10	
20	SS	0.0937	0.0937	0.06250	0.06250	1	DCEN(SP)	90-125	12	11	10	
21	SS	0.1250	0.1250	0.06250	0.09375	1	DCEN(SP)	110-145	12	11	10	
22	SS	0.1875	0.1875	0.09375	0.09375	1	DCEN(SP)	150-275	12	9	15	
23	SS	0.2500	0.2500	0.12500	0.12500	1	DCEN(SP)	200-375	12	5	15	
24	SS	0.5000	0.5000	0.12500	0.12500	1	DCEN(SP)	225-475	12	3	15	
25	GCI	0.0500	0.0500	0.06250	0.06250	1	DCEN(SP)	40-60	12	16	19	
26	MCI	0.0500	0.0500	0.06250	0.06250	1	DCEN(SP)	40-60	12	16	19	
27	GCI	0.0625	0.0625	0.09375	0.09375	1	DCEN(SP)	70-90	12	11	19	
28	MCI	0.0625	0.0625	0.09375	0.09375	1	DCEN(SP)	70-90	12	11	19	
29	GCI	0.0937	0.0937	0.09375	0.09375	1	DCEN(SP)	90-110	12	11	19	
30	MCI	0.0937	0.0937	0.09375	0.09375	1	DCEN(SP)	90-110	12	11	19	
31	GCI	0.1250	0.1250	0.12500	0.12500	1	DCEN(SP)	115-140	12	11	20	
32	MCI	0.1250	0.1250	0.12500	0.12500	1	DCEN(SP)	115-140	12	11	20	
33	GCI	0.1875	0.1875	0.15600	0.15600	1	DCEN(SP)	160-200	12	10	25	
34	MCI	0.1875	0.1875	0.15600	0.15600	1	DCEN(SP)	180-200	12	10	25	
35	GCI	0.1875	0.1875	0.15600	0.15600	2	DCEN(SP)	160-180	12	11	25	
36	MCI	0.1875	0.1875	0.15600	0.15600	2	DCEN(SP)	160-180	12	11	25	
37	GCI	0.2500	0.2500	0.18750	0.18750	1	DCEN(SP)	230-250	12	10	30	
38	MCI	0.2500	0.2500	0.18750	0.18750	1	DCEN(SP)	230-250	12	10	30	
39	GCI	0.2500	0.2500	0.15625	0.18750	2	DCEN(SP)	200-220	12	9	30	
40	MCI	0.2500	0.2500	0.15625	0.18750	2	DCEN(SP)	200-220	12	9	30	
41	GCI	0.3750	0.3750	0.18750	0.18750	2	DCEN(SP)	250-310	12	8	35	
42	MCI	0.3750	0.3750	0.18750	0.18750	2	DCEN(SP)	250-310	12	8	35	
43	GCI	0.5000	0.5000	0.18750	0.18750	3	DCEN(SP)	300-350	12	8	35	
44	MCI	0.5000	0.5000	0.18750	0.18750	3	DCEN(SP)	300-350	12	8	35	
45	Al	0.0468	0.0468	0.06250	0.06250	1	AC	40-60		14-18	20	
46	Alal	0.0468	0.0468	0.06250	0.06250	1	AC	40-60		14-18	20	
47	Al	0.0625	0.0625	0.06250	0.09375	1	AC	70-100		8-10	20	
48	Alal	0.0625	0.0625	0.06250	0.09375	1	AC	70-100		8-10	20	

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	AC	[illegible]	[illegible]	0
[illegible]	Al	[illegible]	[illegible]	[illegible]	[illegible]	1	AC	[illegible]	[illegible]	0
[illegible]	Al+1	0.1250	0.1250	0.12500	0.12500	1	AC	110-150	10-12	0
[illegible]	Al+1	0.1250	0.1250	0.12500	0.12500	1	AC	110-150	10-12	0
[illegible]	Al	[illegible]	0.1875	0.15625	0.15625	2	AC	125-190	10-12	0
[illegible]	Al+1	0.1875	0.1875	0.15625	0.15625	2	AC	125-190	10-12	0
55	Al	0.2500	0.2500	0.18750	0.18750	2	AC	190-270	8-10	0
56	Al+1	0.2500	0.2500	0.18750	0.18750	2	AC	190-270	8-10	0
57	Al	0.3750	0.3750	0.25000	0.18750	2	AC	240-375	8-10	0
58	Al+1	0.3750	0.3750	0.25000	0.18750	2	AC	240-375	8-10	0
59	Al	0.5000	0.5000	0.25000	0.25000	3	AC	400-470	6	0
60	Al+1	0.5000	0.5000	0.25000	0.25000	3	AC	400-470	6	0
61	Al	1.0000	1.0000	0.25000	0.25000	5	AC	350-600	5	0
62	Al+1	1.0000	1.0000	0.25000	0.25000	5	AC	350-600	5	0
63	Cu	0.0625	0.0625	0.06250	0.06250	1	DCEN(SP)	130-150	10	0
64	Cu	0.1250	0.1250	0.09375	0.00000	1	DCEN(SP)	175-225	11	0
65	Cu	0.1250	0.1250	0.09375	0.09375	1	DCEN(SP)	175-225	11	0
66	Cu	0.1250	0.1250	0.09375	0.09375	1	DCEN(SP)	200-250	9	0
67	Cu	0.1875	0.1875	0.12500	0.12500	1	DCEN(SP)	190-225	10	30
68	Cu	0.1875	0.1875	0.12500	0.12500	1	DCEN(SP)	205-250	8	30
69	Cu	0.2500	0.2500	0.12500	0.12500	1	DCEN(SP)	225-260	9	30
70	Cu	0.2500	0.2500	0.12500	0.12500	1	DCEN(SP)	250-280	7	30
71	Cu	0.3750	0.3750	0.18750	0.18750	2	DCEN(SP)	280-320	N.AV.	40
72	Cu	0.3750	0.3750	0.18750	0.18750	3	DCEN(SP)	300-340	N.AV.	40
73	Cu	0.5000	0.5000	0.25000	0.25000	3	DCEN(SP)	375-325	N.AV.	40
74	Cu+Al	0.0000	0.0625	0.06250	0.06250	1	AC	25-80	N.AV.	25
75	Cu+Al	0.0625	0.1250	0.09375	0.12500	1	AC	60-175	N.AV.	25
76	Cu+Al	0.1250	0.3750	0.15625	0.15625	3	AC	220-330	N.AV.	30
77	Cu+Si	0.0625	0.0625	0.06250	0.06250	1	DCEN(SP)	90-120	12	15
78	Cu+Si	0.1250	0.1250	0.06250	0.09375	1	DCEN(SP)	130-160	10-12	15
79	Cu+Si	0.1875	0.1875	0.09375	0.12500	1	DCEN(SP)	150-225	N.AV.	20
80	Cu+Si	0.2500	0.2500	0.09375	0.12500	3	DCEN(SP)	150-225	N.AV.	20
81	Cu+Si	0.3750	0.3750	0.12500	0.12500	3	DCEN(SP)	230-300	N.AV.	20
82	Cu+Si	0.5000	0.5000	0.12500	0.12500	5	DCEN(SP)	250-325	N.AV.	20
83	Cu+Si	0.7500	0.7500	0.12500	0.18750	10	DCEN(SP)	300-350	N.AV.	20
84	Cu+Si	1.0000	1.0000	0.12500	0.25000	13	DCEN(SP)	300-350	N.AV.	20
85	Cu+Ni	0.0000	0.1250	0.18760	0.12500	1	DCEN(SP)	300-310	5	27
86	Cu+Ni	0.1250	0.3750	0.18760	0.12500	3	DCEN(SP)	300-310	6	27
87	Mg	0.0400	0.0400	0.06250	0.09375	1	AC	35	N.AV.	12
88	Mg	0.0630	0.0630	0.09375	0.09375	1	AC	50	N.AV.	12
89	Mg	0.0800	0.0800	0.09375	0.09375	1	AC	75	N.AV.	12
90	Mg	0.1000	0.1000	0.09375	0.09375	1	AC	100	N.AV.	12
91	Mg	0.1250	0.1250	0.09375	0.12500	1	AC	125	N.AV.	12
92	Mg	0.1900	0.1900	0.12500	0.12500	1	AC	160	N.AV.	15
93	Mg	0.2500	0.2500	0.15625	0.12500	2	AC	175	N.AV.	20
94	Mg	0.3750	0.3750	0.15625	0.15625	3	AC	175	N.AV.	20
95	Mg	0.3750	0.3750	0.18750	0.12500	2	AC	200	N.AV.	20
96	Mg	0.5000	0.5000	0.18750	0.12500	2	AC	250	N.AV.	20
97	Ti	0.0240	0.0240	0.06250	0.00000	1	DCEN(SP)	20-35	6	18
98	Ti+1	0.0240	0.0240	0.06250	0.00000	1	DCEN(SP)	20-35	6	18
99	Ti	0.0430	0.0430	0.06250	0.00000	1	DCEN(SP)	85-140	6	18
100	Ti	0.0930	0.0930	0.09375	0.06250	1	DCEN(SP)	170-215	8	25
101	Ti+1	0.0930	0.0930	0.09375	0.06250	1	DCEN(SP)	170-215	8	25
102	Ti	0.1250	0.1250	0.09375	0.06250	1	DCEN(SP)	190-235	8	25
103	Ti+1	0.1250	0.1250	0.09375	0.06250	1	DCEN(SP)	190-235	8	25
104	Ti	0.1880	0.1880	0.09375	0.12500	2	DCEN(SP)	220-280	8	25
105	Ti+1	0.1880	0.1880	0.09375	0.12500	2	DCEN(SP)	220-280	8	25
106	Ti	0.2500	0.2500	0.12500	0.12500	2	DCEN(SP)	275-320	8	30
107	Ti+1	0.2537	0.2500	0.12500	0.12500	2	DCEN(SP)	275-320	8	30
108	Ti	0.3750	0.3750	0.12500	0.12500	2	DCEN(SP)	300-350	6	35
109	Ti+1	0.3750	0.3750	0.12500	0.12500	2	DCEN(SP)	300-350	6	35
110	Ti	0.5000	0.5000	0.12500	0.18750	3	DCEN(SP)	325-425	6	40
111	Zr	0.0080	0.0080	0.04700	0.00000	1	DCEN(SP)	45	20	0.20
112	Hf	0.0080	0.0080	0.04700	0.00000	1	DCEN(SP)	45	20	0.20
113	Zr	0.0160	0.0160	0.04700	0.00000	1	DCEN(SP)	80	25	0.23
114	Hf	0.0160	0.0160	0.04700	0.00000	1	DCEN(SP)	80	25	0.23
115	Zr	0.0240	0.0240	0.05900	0.00000	1	DCEN(SP)	125	20	0.27
116	Hf	0.0240	0.0240	0.05900	0.00000	1	DCEN(SP)	125	20	0.27

117	Zr	0.0390	0.0390	0.07900	0.00000	1 DCEN(SP)	150		20	0.27	0
118	Hf	0.0390	0.0390	0.07900	0.00000	1 DCEN(SP)	150		20	0.27	0
119	Zr	0.0590	0.0590	0.11800	0.00000	1 DCEN(SP)	160		20	0.27	0
120	Hf	0.0590	0.0590	0.11800	0.00000	1 DCEN(SP)	160		20	0.27	0
121	Zr	0.0790	0.0790	0.11800	0.00000	1 DCEN(SP)	180		20	0.27	0
122	Hf	0.0790	0.0790	0.11800	0.00000	1 DCEN(SP)	180		20	0.27	0
123	Ta	0.0200	0.0200	0.06250	0.00000	1 DCEN(SP)	65-78	9	16.5	0.44	0
124	Ta	0.0400	0.0400	0.06250	0.00000	1 DCEN(SP)	140-150	9	15	0.44	0
125	Ta	0.0600	0.0600	0.06250	0.00000	1 DCEN(SP)	200	10	14	0.44	0
126	Ta	0.0800	0.0800	0.06250	0.00000	1 DCEN(SP)	235-240	11	10.5	0.44	0
127	Ta	0.1000	0.1000	0.09375	0.00000	1 DCEN(SP)	250-260	10	9.5	0.44	0
128	Ta	0.1200	0.1200	0.09375	0.00000	1 DCEN(SP)	350	8	16.5	0.44	0
129	Ta	0.1400	0.1400	0.09375	0.00000	1 DCEN(SP)	350	8	13	0.44	0
130	Ta	0.1500	0.1500	0.12500	0.00000	1 DCEN(SP)	350	8	12.5	0.44	0